

OPERATING AND SERVICE MANUAL

BLH METERITE BSA-250B TWO CHANNEL RECORDER

BLH ELECTRONICS, INC.

A subsidiary of Baldwin • Lima • Hamilton Corporation
WALTHAM, MASSACHUSETTS 02154 • (617) 894-6700



890-6700

TM-BSA-250BA-1

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MANUAL CHANGES

MODEL BSA-250B/270B/270BA

MANUAL TITLE 2-Channel Oscilloscope

MANUAL PREFIX TM-BSA-250BA-1

MAKE ALL CHANGES IN THIS MANUAL ACCORDING TO ERRATA AND CHANGE(S) LISTED BELOW

NOTE: This Instruction Manual covers the following models of the BLH Portable, 2-Channel Oscilloscope:

- a. Model BSA 250B Portable, 2-Channel, Ink Writing Oscilloscope.
- b. Model BSA 270B Portable, 2-Channel, Manual Heat Control, Thermal Writing Oscilloscope.
- c. With Appendix "A", included at the rear of this Manual, the Model BSA 270BA Portable, 2-Channel, Automatic Heat Control, Thermal Writing Oscilloscope.

INSTRUCTION MANUAL
FOR
BLH METERITE
MODELS BSA-250B/260B/270B

Designed and Manufactured by

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BLH DIRECT WRITING RECTILINEAR OSCILLOGRAPHIC RECORDERS

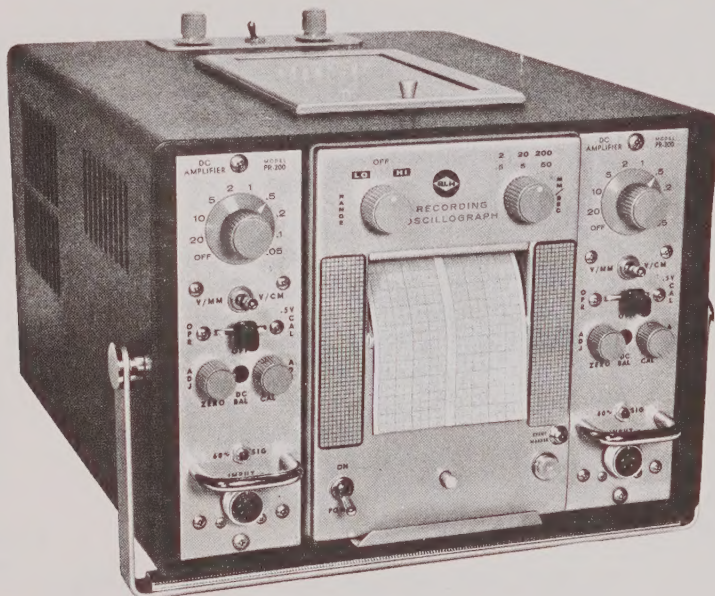


Fig. 1-1 Model BSA-260B or BSA-270B Oscillographic Recorder

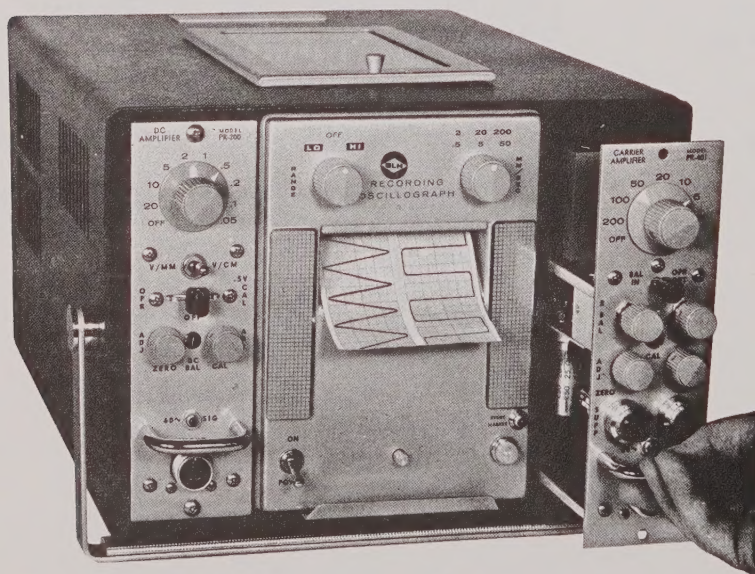


Fig. 1-2 Model BSA-250B Oscillographic Recorder and Plug-in Preamplifier

Section 1

INTRODUCTION

1.1 General (Figure 1-1)

This instruction manual provides information regarding the description, applications, operation, theory and maintenance for the BLH "Meterite" Direct Writing Rectilinear Oscillographs.

NOTE: Unless otherwise specified in the particular paragraph, whenever the Model BSA-260 B, or "Meterite" is mentioned, equal reference is made to Models BSA-250B, BSA-260B and BSA-270B.

CAUTION: PLEASE DO NOT attempt to energize this equipment nor operate the controls until Section 2 has been read and understood. To do so may cause damage, the repairs of which may not be covered in the warranty.

1.2 Comparison of the Meterite Models.

The Meterites provide direct writing ink, electric, or thermotip oscillograms on a two track chart with rectilinear coordinates. Each Chart track is 40 millimeters wide and the associated circuitry for each channel is completely isolated so that independent oscillograms may be written on either or both tracks without interference with one another.

1.2.1 The Model BSA-250B (Fig. 1-2)

The Model BSA-250B provides direct writing oscillograms using ink writing pens exclusively. Except for the circuitry necessary to support the electric or heat writing function, the Model BSA-250B is identical to the Models BSA-260B and BSA-270B. In fact, the Model 250B is quickly converted to a Model BSA-260B or BSA-270B by a simple installation of a conversion kit. This kit, described in complete detail in Section 4, paragraph 4.6, may be purchased from BLH Electronics. The installation may be carried on by your own technical people, or your Model BSA-250B may be returned to BLH Electronics for factory conversion at a nominal fee.

1.2.2 The Model BSA-260B.

The Model BSA-260B provides direct ink or electric oscillograms.

One may change the mode of writing of both channels from electric to ink (or vice versa) by a simple change of stylus and chart paper. The conversion takes but a few moments.

1.2.3 The Model BSA-270B.

The Model BSA-270B provides direct writing oscillograms using thermotip or ink writing pens.

The mode of writing of both channels may be converted by a simple change of stylus and chart paper.

The BLH "Meterite", Model BSA-260B (with preamplifiers) is a complete two channel recording system. When used with a BLH Preamplifier PR-100, PR-200, PR-300 or PR-401 (with 2500 cps carrier), the "Meterite" is capable of recording electrical signals from DC to over 100 cps. When using a PR-401 preamplifier with one of the optional carrier frequencies, the "Meterite" frequency response is limited to approximately 20% of this carrier frequency.

The "Meterite", due to the exclusive mechanical linkage in the BLH Pen Motor, permits the use of conventional Cartesian co-ordinates on continuous graph paper.

1.4 Mechanical Considerations.

The Model BSA-260B is constructed in modular form and includes a pair of complete (and isolated) recording channels, mounted on an easily serviced, pull-out drawer, as shown in Figure 2-2. The outer enclosure provides two chambers for the insertion of any BLH plug-in preamplifier. These chambers are located on either side of the central drawer.

The preamplifiers in use, depend on the particular characteristics of the data recorded. You will find complete descriptions of the preamplifiers ordered with your "Meterite" in the instruction books which accompany this manual.

The outer case includes a swingout carrying handle. Rubber feet are provided on the rear panel to permit the temporary resting of the "Meterite". The recorder should not be operated on end, however, but in the normal horizontal position.

Weighing but 37 pounds (less preamplifiers), the "Meterite" is portable and fits into a space only 14-1/4 inches wide, 11 inches high and 16-3/4 inches deep.

1.5 Electrical Considerations.

Each channel is equipped with its own power supply and operates independently of the other channel. The supply also powers the preamplifier in use in the channel. Because each channel is isolated from the other, no cross-talk occurs. Thus signals of widely varying amplitudes may be recorded on the adjacent channels without interference.

A fully transistorized driver amplifier, BLH Model DA-101B, converts the preamplifier output to a signal suitable to drive the pen motor. This amplifier is used as a single ended or differential amplifier depending on the demands of the preamplifier used. The circuitry is arranged to make the necessary change-over, automatically, when the preamplifier is plugged in. Two of these driver amplifiers (one for each channel) are used in the Model BSA-260B and complete details about the circuits are found in Section 3, paragraph 3.

Long component life with a minimum of maintenance has been designed into the Model DA-101B. Transistors eliminate the problem of microphonics, while a

large amount of current feedback stabilizes the operation.

One special event marker produces "pips" to indicate special events or time intervals. This event marker pen writes on the right hand side of the chart paper.

An optical internal Automatic Timer and additional event marker provide "pips" between the chart paper grids.

The internal automatic timer, the front panel EVENT MARKER pushbutton and two rear-panel remote jacks are associated with these markers. The use of these markers is described in Section 2, paragraph 2.4.3.

Full operating power from the 115 volt (60 cps) line is approximately 90 watts including the requirements of the preamplifiers.

1.6 Controls. (Figures 1-3A and 1-3B)

Controls are provided to adjust the speed of chart travel (0.5, 2, 5, 20, 50 and 200 millimeters per second). A master power switch and the "local" event marker push-button complete the front panel controls.

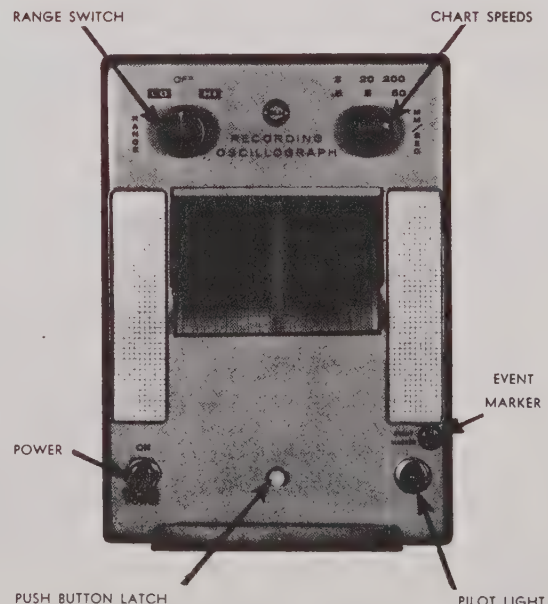


Fig. 1-3A "Meterite" Front Panel Controls

On the Model BSA-260B and BSA-270B (only) there are three more controls at the rear of the top deck. These are associated with the electric or thermotip styli, and are not included in the Model BSA-250B.

The Thermotip Writing Controls are identical to the Electric Writing Controls shown in Figure 1-3B except for the name plate marking.

Further details as to the function of these controls will be found in Section II.

CAUTION: PLEASE DO NOT attempt to energize this equipment nor operate the controls until Section 2 has been read and understood. To do so may cause damage, the repairs of which may not be covered in the warranty.

1.7 Applications.

Because of the flexibility afforded by the many different preamplifiers available, your "Meterite" may be used to record practically any phenomenon which can be transduced into an electrical signal. Nor is its use restricted to the laboratory because of its portability and ruggedness, it may be taken aboard aircraft and shipboard for maintenance purposes; out in oil fields for exploration purposes; throughout utility companies generation substations for emergency measurements and preventive maintenance procedures. These are just examples of use for the Model BSA-260B. Other applications have included checkouts for missile systems and other locations where heretofore larger recording systems deemed it impractical. In addition to the above, the "Meterite" is still the highly accurate instrument necessary in research, development and manufacturing facilities for testing of new and production products and materials.

You will find that, after you have spent a few minutes familiarizing yourself with the various simple controls, that the Model BSA-260B will be an extremely useful instrument.

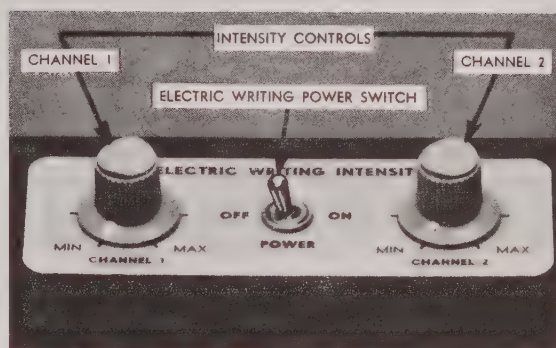


Fig. 1-3B "Meterite" Electric Writing Intensity Controls

Specifically, the Model BSA-260B is first and foremost a recorder. The reproduced waveforms can be relied upon to be just like those of the actual transduced signal. Still, however, because this recorder can handle signals in the extremely low AC (extending to zero frequency), the instrument may be used, for example, as a phase meter for extremely low frequencies, eliminating the need for specialized instruments.

"Cycle-per hour" measurements may be compared by operating at the slowest chart speed, with one channel monitoring the reference frequency and the unknown phase driving the second channel. In this case, where the chart speed is but 1/2 mm/second, only about 6 feet of chart paper is consumed per hour. On the other extreme, where 100 cps signals are recorded, the 200 mm/second chart speed means that each cycle will occupy two full longitudinal millimeter chart paper divisions for fine waveform resolution.

1.8 Designation of Channels.

To differentiate between the channels, the following convention has been adopted. Channel 1 is on the left as the operator faces the front of the "Meterite".

Section 2

OPERATION

2.1 General.

This section provides information about unpacking, preliminary inspection (after shipment) and the actual operation of the Model BSA-260B and also refers to the auxiliary preamplifiers and equipment.

CAUTION: PLEASE DO NOT attempt to energize this equipment nor operate the controls until this section has been read and understood. To do so may cause damage, the repairs of which may not be covered in the warranty.

NOTE: Unless otherwise specified in the particular paragraph, whenever the Model BSA-260 B, or "Meterite" is mentioned, equal reference is made to Models BSA-250B, BSA-260 and BSA-270B.

2.2 Unpacking.

The "Meterite" is shipped in a large cardboard container and is isolated from normal shipping shocks by suitable padding materials. Observe any cautions printed or stenciled on the container. The instructions in this manual are for reference in the event that the "Meterite" is re-shipped by the owner. Section 4, paragraph 4.11 provides packing and shipping instructions.

Unpacking Instructions:

Slit the outside tapes, being careful not to cut too deeply.

Open the box flaps, and remove the cardboard flat and the technical manual beneath.

Remove the front and rear separators.
2-1

Lift the instrument (approximately 40 pounds) by grasping the top of the front and rear areas. (The two side separators will drop to the bottom of the box.)

It is suggested that the shipping container and the separators be saved for possible future shipment to another point or to the BLH factory for instrument service should this be necessary.

Carefully clip the tape which secures the plastic bag surrounding the instrument. Place the instrument on a convenient surface for visual inspection per instructions in the next paragraph.

2.3 Inspection after Shipment.

Reasonable care has been taken to pack the Model BSA-260B in a manner such that it will reach you in perfect operating condition. However, to assure that your "Meterite" has not been damaged in shipment, make the following checks before operating or applying power.

2.3.1 Exterior. (See Figure 2-1.)

Observe the front panel (exclude preamplifiers) and rear of top deck of Model BSA-260B and note that the controls appear as in Fig. 2-1, 1-3A and 1-3B. Model BSA-250B has no controls at the rear of top deck (Fig. 1-2).

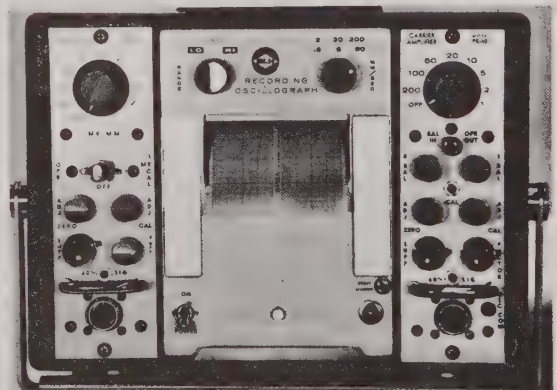


Fig. 2-1 Front View of "Meterite"

2.3.2 Interior. (See Figure 2-2 and 2-3)

Remove the preamplifiers by backing off the screws at the top and bottom. For fuller information, refer to the appropriate preamplifier manual which accompanies this instruction book.

Open the center drawer by pressing the pushbutton latch (bottom center of front panel), and slide drawer out about three inches. Open top panel window and observe the pens. Pull drawer out against its stops, compare the interior view to Fig. 2-3. Note that the Electric or Heat Writing Power Supply is provided on Models BSA-260B or BSA-270B only.

If your Model BSA-260B order did not include a BLH Automatic Chart Take-Up Unit, the front panel will be blank below the chart paper exit slot. Beneath the decorative panels are predrilled holes to accept the BLH Automatic Chart Take-Up Unit, should one be desired. The unit is simple to install and eliminates the clutter of uncontrolled used chart paper. You may order a BLH Automatic Chart Take-Up Unit from BLH Electronics. Installation instructions are provided in Section 4, paragraph 4.8.

2.4 Controls.

The Model BSA-260A (only) has three

basic groups of controls: on the front panel, on the preamplifiers, and along the rear of the top deck. The BSA-250B has the same front panel and preamplifier controls, but has a decorative panel at the rear of the top surface. This panel is removed and replaced by the electric or heat stylus power controls when so installed. See paragraph 4.6, of Section 4.

2.4.1 Front Panel Controls. (See Figure 1-3A.)

The front panel controls on the "Meterite" are found on the center panel which is part of the pull-out drawer chassis.

Name of Control	Function
RANGE	Low Speed / Off / High Speed control of chart paper.
MM/SEC	.5 / 5 / 50 millimeters per second (with RANGE on "LO"). 2 / 20 / 200 millimeters per second (with RANGE on "HI").
POWER	Master Power Switch
EVENT MARKER	Manual Event Marker Pushbutton

NOTE: The lamp at the lower right is the power on indicator.

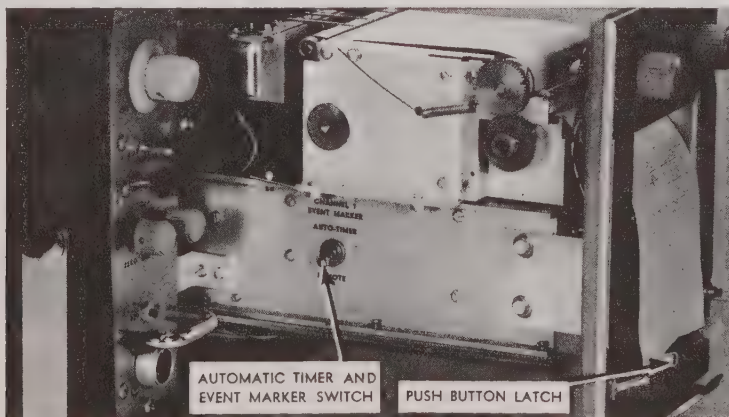


Fig. 2-2 "Meterite", Pull-out Recorder Section

2.4.2 Controls on Rear of Top Deck (Models BSA-260B and BSA-270B only. (See Figure 1-3B.)

Position of Control (as viewed from front)	Function
CHANNEL 1	Controls Channel 1 line intensity.
POWER	ON-OFF Control for Heat or Electric Writing.
CHANNEL 2	Controls Channel 2 line intensity.

NOTE: For the convenience of converting the Model BSA-250B to a Model BSA-260B or BSA-270B, the position for these controls is pre-cut and covered with a plate.

2.4.3 Automatic Timer, Event Marker and Remote Control. (See Figure 2-2.)

A switch selected automatic timing marker produces "pips" once per second between the channels at all chart speeds. The same stylus may be used for remote event marking. A switch on the left frame of the pull out drawer (See Figure 2-2) selects the operational mode of this central stylus.

2.4.3.1 Event Marker and Remote Control.

The rear panel of the Model 260B has two jacks into which remote event marker control circuits may be plugged. The lower jack is in parallel with the front panel marker pushbutton and controls the

event marking pen on the right chart edge. The upper jack is connected to circuitry which operates the event marking pen located between the charts. (See Figure 2-4.)

2.5 Driver Amplifier DA-101B DAMPING CONTROL

A screw driver adjustment located on the rear of each Drive Amplifier permits setting a potentiometer to control the pen motor damping. By rotating the screw slot fully counterclockwise, 30% of critical damping is reached; by rotating the screw slot fully clockwise, 110% of critical damping results. Any percent of damping between the two can be attained by adjusting this control.

CAUTION: Driver Amplifiers are set at 70% of critical during manufacture. All frequency response specifications are based on this setting. If the pen motor damping control is adjusted for any reason, be sure to return it to 70% (see Section 4) before making recording runs which rely on specified recorder frequency response characteristics.

2.6 Preamplifier Controls.

Each preamplifier is slightly different and the reader is referred to the appropriate preamplifier instruction manual which accompanies this book.

2.7 Replacing the Chart Paper.

NOTE: Do not energize the equipment unless chart paper is installed.

2.7.1 Installing the Chart Paper. (See Figure 2-5.)

Follow the steps listed below to install a roll of chart paper.

NOTE: Generally this operation includes the removal of the old chart paper. For those instructions, see sub-paragraph 2.7.2, immediately below the paper installation steps which follow.

1. Pull out the Recorder Section Drawer by first depressing the latch button in the lower center portion of the panel.

2. Raise the writing pens from the paper table by rotating pen lifting clips to a vertical position (Figure 2-5A).

3. Unscrew Chart Retainer Knob.

4. Position new chart paper roll on spindle as shown in Figure 2-5B. This will assure the correct orientation of the recording chart. Replace Chart Retainer Knob.

5. Feed the free end of the chart paper up over the rear roller on the paper table (Figure 2-5B).

6. Lift the paper hold-down spring until it just clears the screws on either side of the paper table (Figure 2-5B). Slide the paper forward and under the hold-down spring then return the spring to its normal (down) position (Figure 2-5C).

7. Turn the equipment master (power) switch OFF. Turn preamplifiers' signal controls OFF. Set chart speed RANGE switch to OFF and MM/SEC control to 5. Turn Power Switch ON. With chart paper held between Teflon Roller and Paper Table Front Roller, put RANGE switch to LO (Figure 2-5C). The paper will now feed between the rollers. Guide the paper through the exit slot and onto Automatic Take-Up Unit (when so equipped). (See Figure 2-5D.)

8. Put RANGE switch to OFF; MM/SEC control to 200 then put RANGE switch to HI and let approximately one foot of paper pass through the mechanism, then turn RANGE switch OFF.

9. Return the pen lifting clips to the horizontal position (Figure 2-5A), and close the recorder drawer. The "Meterite" is now ready to record.

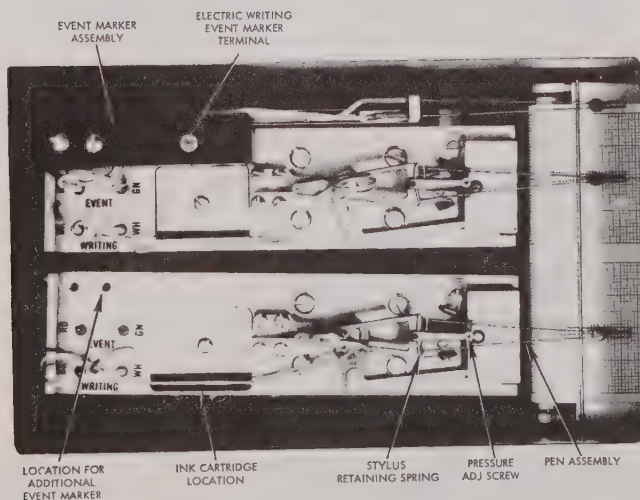


Fig. 2-3 Meterite Pen Motors

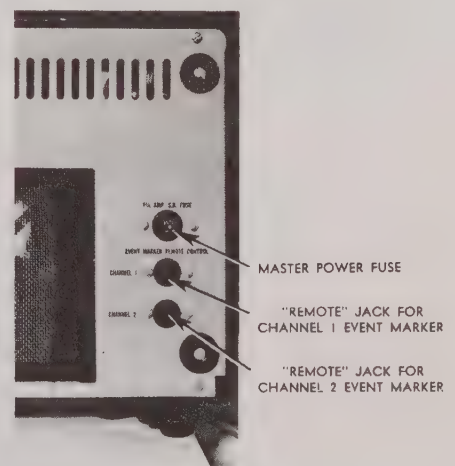


Fig. 2-4 Rear Panel Event Marker Jacks

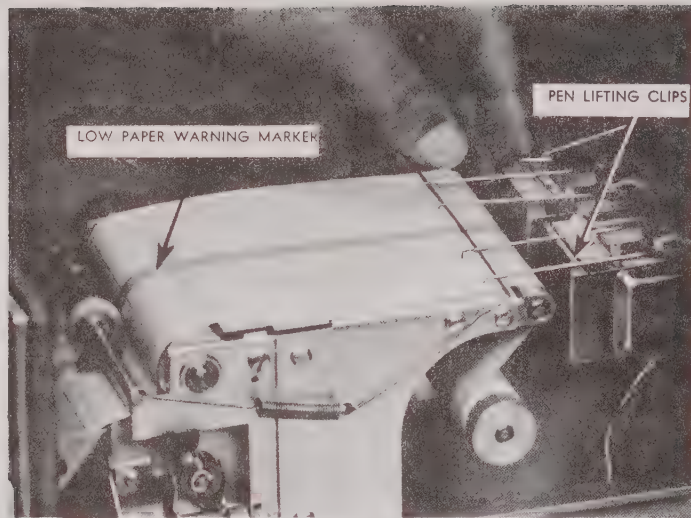


Fig. 2-5A Rotating Pen Lifting Clips

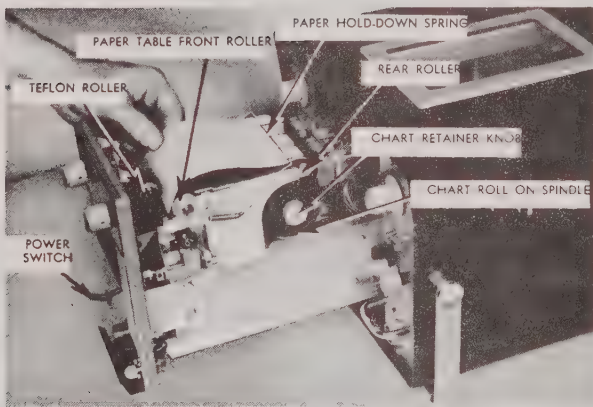


Fig. 2-5B Chart Paper Installation

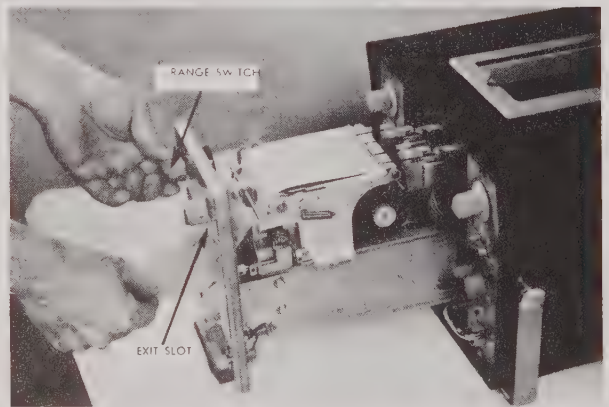


Fig. 2-5C Threading Paper Electrically

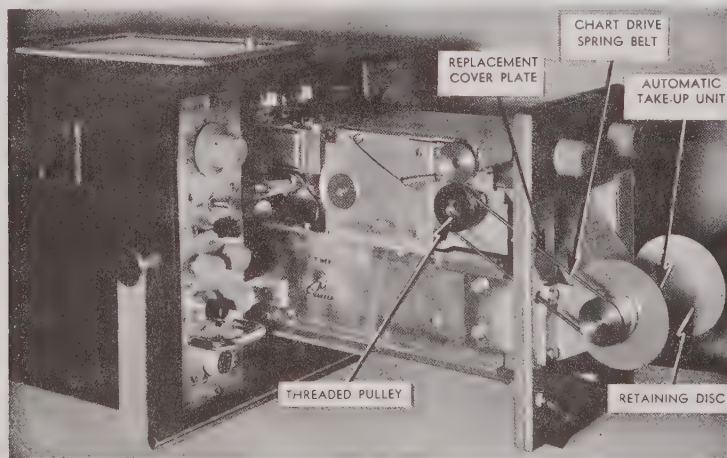


Fig. 2-5D Automatic Paper Take-Up Unit

2.7.2 Removing Exhausted Chart Paper Roll.

The steps listed below should be followed when removing an exhausted chart paper roll.

1. Turn main power OFF.
2. Pull out the Recorder Section.
3. Raise the writing pens from the paper by rotating the pen lifting clips (Figure 2-5A).
4. Separate the remaining chart paper from the roll by breaking the masking tape.
5. Set Chart Speed RANGE switch to OFF and MM/SEC Control to 5. Turn Power Switch ON. Paper will now run out automatically. Stop the machine when paper is free.
6. If your "Meterite" is equipped with an Automatic Chart Take-Up Unit (Figure 2-5D), take the following steps. If not so equipped, replace the paper with a new roll according to the instructions in paragraph 2.7.1, above.
7. Slip off the roll retaining disc on the right side of the Automatic Chart Take-Up Unit by pulling on the KNOB provided.
8. Remove the old chart paper roll.
9. Retrieve the cardboard core (1 inch in diameter) from the accumulated chart paper and return the core to its position on the Automatic Chart Take-Up Unit. A slotted hub on the remaining retaining disc will hold the core until the free retaining disc is replaced.
10. Replace the chart paper roll following the instructions of paragraph 2.7.1, above.

2.8 Initial Application of Input Signals.

The Model BSA-260B is a sensitive

instrument and should be operated with the same regard to attenuator settings as is the case with scale settings on a standard multimeter. Please read this section thoroughly before attempting to use the "Meterite".

The BSA-260B comes with a variety of preamplifiers. Because the major operation of the unit is centered at the PREAMPLIFIER controls, please refer to Section II in the appropriate preamplifier manual.

2.8.1 Initial Control Settings. See Figure 1-3A and 1-3B

Control	Position
Power Switch	OFF
Range Switch (LO/OFF/HI)	OFF
Pen Line Intensity Controls (Models BSA-260B and BSA-270B ONLY)	Fully Counter-clockwise
Electric or Heat Writing Power Switch (Models BSA-260B and BSA-270B ONLY)	OFF (left)

Set preamplifier controls as per Section 2 of the appropriate preamplifier manual.

2.9 Points to Remember.

The pens will NOT write if the elevating clips are in vertical position. (See Figure 2-5A.)

The electric or thermotip pens will NOT write if they are NOT energized. (See Figure 1-3B.)

The ink writing pens will NOT operate if there is no ink.

DO NOT UNPLUG a preamplifier unless the master switch is OFF.

DO NOT PLUG IN a preamplifier unless the master switch is OFF.

Be sure pen writing tips are contacting chart paper.

DO NOT BEND the stylus to position it with relation to the chart. Follow the instructions in the Pen Motor Division of this manual.

2.10 Specifications.

2.10.1 General.

CHANNELS

Two 40 mm channels.

EVENT MARKER

One extra pen on right side of chart provides event marking functions. See paragraph 2.4.3 above.

AUTOMATIC TIMING EVENT MARKER (optional)

One extrapen between charts provides automatic timing event marking. See paragraph 2.4.3 above.

CHART SPEEDS

Six speeds: 0.5, 2, 5, 20, 50, 200 mm per second selected by front panel controls. Other ranges by special order.

CHART DRIVE

Synchronous motor with variable gear train.

PAPER

Model BSA-250B, ink only. Model BSA-260B, ink or electric. Model BSA-270B, ink or heat. All types graduated in multimeter divisions ruled in rectangular coordinates with an easy-to-read decimal time scale.

PAPER CAPACITY

Electric: 100 feet, maximum; ink: 150 feet, maximum.

Heat: 150 feet, maximum.

PAPER TAKE-UP

Automatic, with Model TK-101A Automatic Chart Take-Up Unit; gravity exit, without the Automatic Chart Take-Up Unit.

WEIGHT

37 pounds (less Preamplifiers)

DIMENSIONS

14-1/4" wide, 11" high, 16-3/4" deep.

POWER REQUIREMENTS

115V, 60 cps, approximately 90 watts (including preamplifiers).

2.10.2 Driver Amplifier Specifications.

MODEL NUMBER

DA-101B, used with 40 mm pen motors.

INPUT

± 1 volt for ± 20 mm.

OUTPUT

± 660 ma maximum into 18 ohm load (maximum).

FREQUENCY RESPONSE

DC to 1 Kc.

DRIFT

Less than .5% of full scale for $\pm 10\%$ line voltage changes and ambient temperature changes of from 20° to 40°C.

GAIN (Transconductance)

0.6 mhos ± 1 volt input gives 660 ma output current.

Section 3

THEORY OF OPERATION

3.1 General.

NOTE: Unless the expression "(only)" appears after the model designation in this description, equal reference is made to Models BSA - 250B, BSA - 260B and BSA - 270B.

The Meterite is a modular instrument. A basic cabinet houses the Pen Motors, the Chart Drive Mechanism, the two Driver Amplifiers, and the chambers in which the associated preamplifiers are plugged. The Model BSA-250B (only) provides ink writing. The BSA-250B may be converted to either heat or electric writing by ordering a simple-to-install conversion kit from BLH Electronics. See Section 4, paragraph 4.6 for more details.

The Model BSA-260B (only) provides both electric and ink writing capabilities. This provision includes a power supply (enclosed within the main chassis), switch and amplitude controls which determine the intensity of the electrically written line.

The Model BSA-270B (only) provides thermotip or ink writing. A power supply and heat amplitude controls control the intensity of the trace.

The Model BSA-250B is identical to the Model BSA-260B in all respects except that no electric writing is provided. A simple-to-install electric writing conversion kit may be ordered from BLH Electronics. See Section 4, paragraph 4.6 for more details.

Because of the modular nature of the Model BSA-260B, an understanding of the preamplifiers is necessary for complete comprehension of the theory of operation. Therefore, it is suggested that after the basic idea of the "Meterite" is understood, that the individual preamplifier manuals be studied as well. The preamplifiers ordered with your Model BSA-260B have individual manuals which were shipped in the same package.

3.2 Block Diagram.

Figure 3-1 shows the simplified block diagram of the Model BSA-260B. An "*" is placed near the items of the block diagram which do not apply to the Model BSA-250B. The signal enters the preamplifier

at the upper left and, after amplification, appears at the signal input terminals of the Driver Amplifier (BLH Model DA-101B). This power amplifier produces the required current to drive the pen motor.

On the Model BSA - 260B (only) the electric stylus is energized by a small current from a high impedance power supply. When the energized stylus comes in contact with the electric writing chart paper, the paper permits current to flow, burning the paper slightly and making a dark mark. Because of the variations in operating conditions due to chart speed, paper variations and humidity, the exact amount of energizing current varies. An intensity control establishes the correct line density. See Figure 1-3B.

On the Model BSA - 270B (only) the thermotip stylus is energized by a special power supply that controls the current through the writing tip. As current is passed through the writing tip, heat is concentrated at the tip and melts and removes a wax-like substance on the chart paper thus exposing a black background. The exposed background represents a trace of the signal being recorded.

Driven by the Model DA-101B, the pen traces a faithful reproduction of the input signal waveform on the moving chart paper. Note that, on the Model BSA-260B, that the co-ordinates of the chart paper are straight and at right angles to each other. This eliminates the guess-work from waveform interpretation necessary when using ordinary curvilinear recorders. For this reason, your Model BSA-260B makes an oscillogram which is much easier to read. You will find that this feature, alone, will make the Model BSA-260B a fine instrument for critical measuring procedures.

3.3 Schematic Discussion of the Model DA-101B Driver Amplifier. (See Figure 4-18.)

The Driver Amplifier uses direct-coupled transistor circuitry. The pen-motor current, flowing from terminal A, J103, is supplied by transistor pair Q108 and Q109, and is equal to the difference in their currents. Under zero signal conditions, each transistor is conducting an

equal amount of current which is slightly greater than half the current that would be needed by the pen motor to give full scale deflection. Since their currents are equal, there is no current in the pen motor and no deflection.

An input signal applied between terminal 9 (+ signal) and terminal 6 (common) of J101 will now cause Q108 to conduct more (or less) current. This causes a change in voltage across R116 which is coupled through Q105 and Q107 to Q109, and causes Q109 to conduct less (or more) an equivalent amount of current. The pen motor now has a current flowing in it equal to the difference in the two transistor currents (or, in other words, equal to the increase in current in one transistor plus the decrease in current in the other transistor).

The input stages of the Model DA-101B consist of Q101, Q102, Q103, and Q104. The first two transistors, forming a differential input circuit, drive Q103 and Q104. However, only a single-ended output is taken from this second differential stage. This output (collector of Q103) drives the base of Q106.

The input stage, Q101 and Q102, may be operated either single ended or differentially. This is to allow maximum flexibility in the design of preamplifiers. The preamplifier determines which type of input is used. (See schematic discussion of preamplifier used to see if its output is single ended or differential.)

The Pen Motor contributes to the system feedback. The pen motor current flows through its driving coil via J103 terminals A and B. Current feedback is developed through R120 and passes through the damping and compensation network to the junction of R127, R128 and R131. Voltage feedback proportional to the amplitude and frequency of the voltage from J103 terminal A is developed by the tank circuit (R130, L101 and C105) and passes through R127 to the junction of R127, R128 and R131.

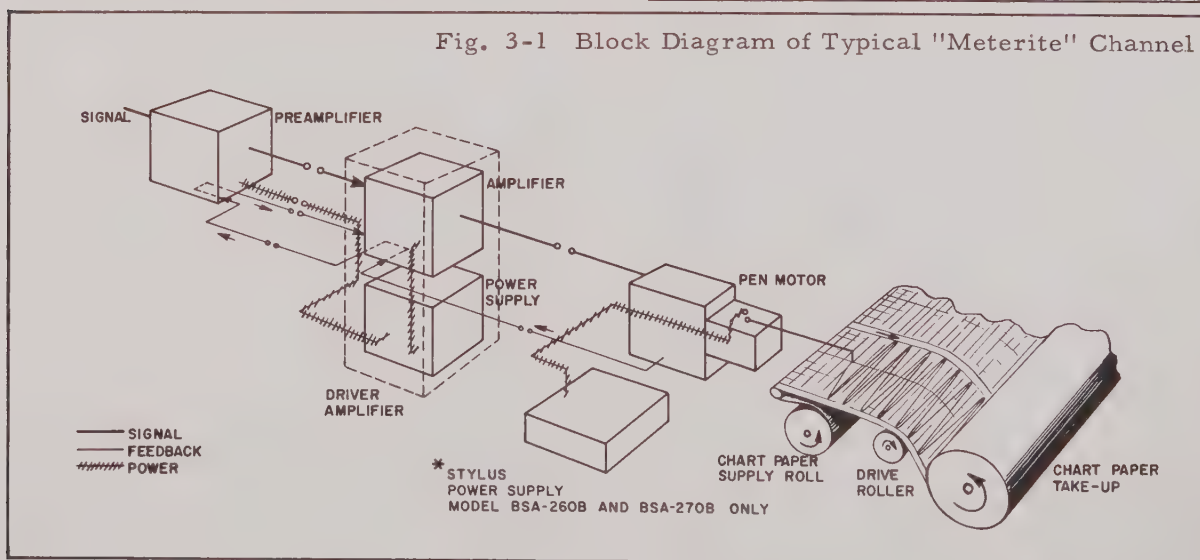
The voltage and current feedback combine at the base of the input transistor Q102 to stabilize the amplifier.

The frequency transmission characteristics of this compensation network are similar to the frequency response characteristic of the pen motor, and since it is in the feedback circuit, the gain of the driver amplifier is modified to produce the widest possible band width from the pen motor. See Table 3-1.

Table 3-1. Maximum Amplitudes vs. Frequency Range

Maximum Amplitude Setting	Maximum Frequency Range
± 20 mm	DC to 40 cps
± 10 mm	DC to 80 cps
± 5 mm	DC to 120 cps

Fig. 3-1 Block Diagram of Typical "Meterite" Channel



Section 4

MAINTENANCE

4.1 General

The Trouble Shooting section of this manual is provided for two basic reasons: (1) Maximize the available operational capability of the "Meterite" and (2) quickly correct certain simple difficulties. Both of these basic aims are for the purpose of keeping the "Meterite" on the line with a minimum amount of down time.

The trouble shooting procedures are divided into three categories: Channelizing, localizing, and isolating. Channelizing finds the faulty module and provides an operating channel whenever possible. Localizing and isolating pinpoint the faulty circuit and component. Component isolation has been limited to changing those transistors which do not require the use of a soldering iron.

There are two channels in the "Meterite". The channelizing procedure makes use of this fact and also the interchangeability of the modules making up the channels. For example, if a driver amplifier is in trouble, in one channel, it is possible to make do with the alternate channel, by exchanging preamplifiers (or even pen motors) when necessary. Thus the "Meterite" can continue to provide service during the down-time of the driver amplifier with the circuit failure.

4.2 Channelizing.

Channelizing uses the pen motors as an indicator and the ZERO control on the preamplifiers for the "test signal". The procedure is simple and easily performed by people with little technical knowledge. Channelizing will permit you to locate the faulty unit and keep the "Meterite" going while the mal-functioning module is out for repair.

Preliminary Steps.

1. Plug the "Meterite" into a conven-

tional AC-power socket.

2. Turn the Master Power Switch ON. Allow to warm up for two minutes or according to preamplifier instructions whichever is longer.

3. After warm up, rotate the preamplifier zero adjust knob to see if the pen may be moved from one edge of the chart to the other edge. If this is possible, calibrate the channel(s) according to the instructions in Section 2 of the appropriate preamplifier manual.

4. If you can sweep and calibrate according to the instructions, the channel is functioning properly.

5. If you are unable to obtain a full deflection or if the calibration procedure cannot be achieved, take the channelizing steps below.

NOTE: In all cases be sure to write down the symptoms in the chart (Figure 4-1) after each step. This minimizes the steps required and generally speeds up the procedure. If the instructions are followed, a complete channelization, localization and isolation run should take no longer than a half-hour or so.

4.3 Channelizing Steps.

NOTE: Module Check Chart (Figure 4-1).

The Module Check Chart is provided for the purpose of keeping a running record of the functional capability of the various modules while the channelizing tests are made. Spaces are provided to check whether the module is "OK", "?", or "NG" as determined during the tests.

When a functioning channel is obtained (with the various channelizing intercon-

Fig. 4-1
Module Check Chart

PREAMPLIFIER 1

DRIVER AMPLIFIER 1

PEN MOTOR 1

PREAMPLIFIER 2

DRIVER AMPLIFIER 2

PEN MOTOR 2

OK	?	NG



Fig. 4-2A Channelizing Step 1:
Observing Pen Motor Response

Fig. 4-2B Block Diagram
of Meterite During Step 1

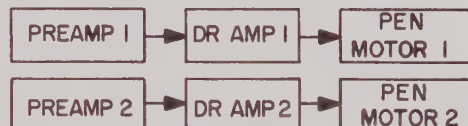


Fig. 4-3, Step 1:
Locating Driver Amplifier Fuses

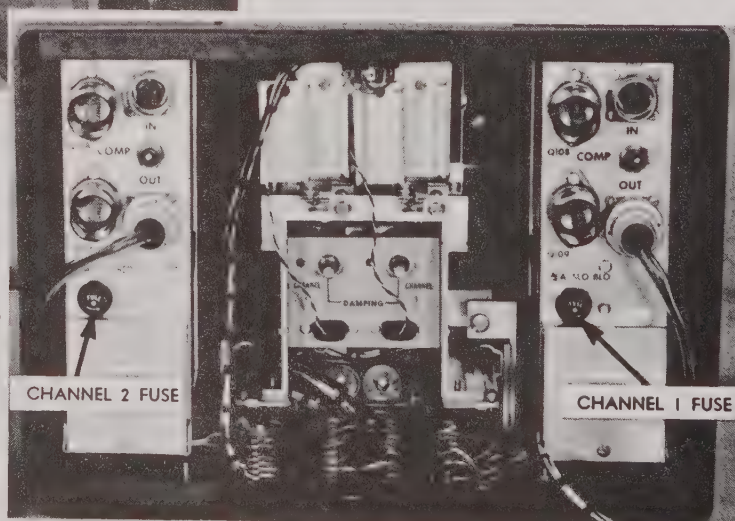


Fig. 4-4A
Channelizing
Step 2
and Step 4
Interchanging
Preamplifiers

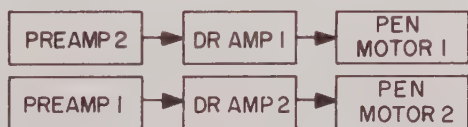
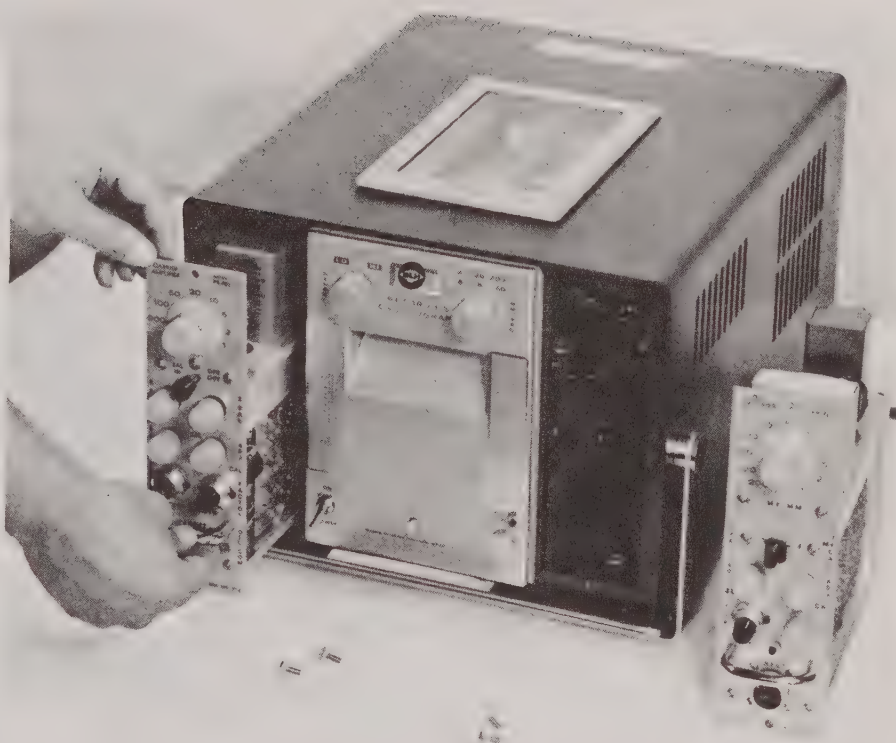


Fig. 4-4B Channelizing Step 2
Block Diagram

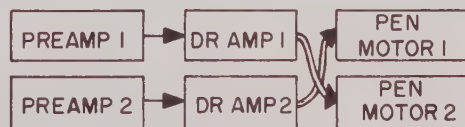
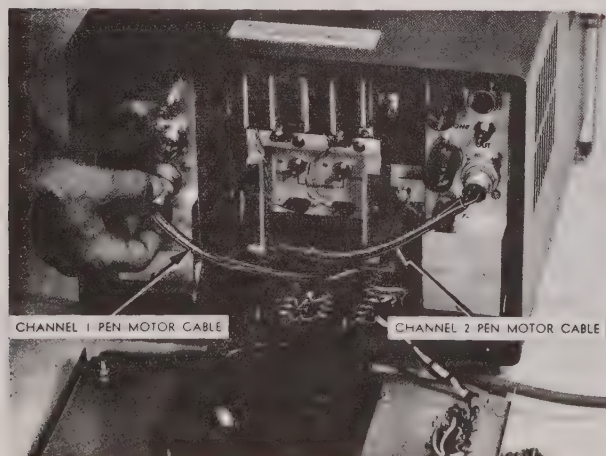


Fig. 4-4C Channelizing Step 4
Block Diagram



CHANNEL 1 PEN MOTOR CABLE

CHANNEL 2 PEN MOTOR CABLE

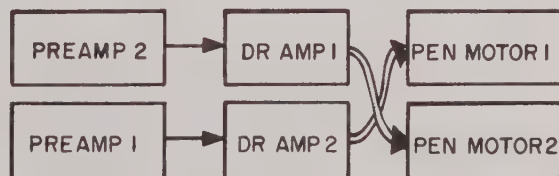


Fig. 4-5B Channelizing Step 3
Block Diagram

Fig. 4-5A Channelizing, Step 3
Interchanging Pen Motor Plugs

nections, below) check marks (✓) should be placed in the "OK" blocks opposite all of the modules making up that particular channel. If a channel does NOT function, checks should be placed in the "?" column unless it is determined that one or more modules are actually not functioning. In that case, the checks should be entered in the appropriate "NG" column.

As the Channelizing steps proceed, a module, originally thought to be inoperative, may later be determined as "OK". In such situations a new check mark should be put in the appropriate "OK" column and the old "?" check mark deleted. DO NOT, however, change an established "OK" to either a "?" or "NG".

Step 1. (See Figures 4-2A, 4-2B)

Turn Power Switch ON. Observe the Pen Motors while the ZERO controls (on the preamplifiers) are rotated. When a pen motor can be made to swing the full width of its channel chart, consider THAT channel to be OK. Any other Pen Motor response is unsatisfactory.

ONLY ONE CHANNEL IN OPERATION.

Put a check mark in the Module Check Chart (Figure 4-1) blocks corresponding to all modules making up the functioning channel. Be sure to include the preamplifier, driver amplifier AND Pen Motor. Turn the Power Switch OFF and take step 2.

NEITHER CHANNEL FUNCTIONING.

If the full sweep cannot be achieved on either channel, place checks in the "?" blocks opposite ALL six modules. Turn the Power Switch OFF. Open the rear of the "Meterite" (Figure 4-3) and check the fuses in the rear of each Driver Amplifier. Replace if blown, close the cabinet and repeat step 1. If no fuse replacement is necessary take step 2.

Step 2. (See Figure 4-4A)

Turn Power Switch OFF. Interchange the preamplifiers so that the preamplifier formerly in Channel 1 is NOW in Channel 2 and vice versa. Turn the Power Switch ON and rotate the ZERO controls on both

preamplifiers, once more. Observe the operation of the respective Pen Motors. If a pen motor can be made to swing the full width of its channel chart consider THAT channel to be OK.

ONLY ONE CHANNEL IN OPERATION.

Put a check mark in any new "OK" Module Check Chart (Figure 4-1) block which was not checked during the previous step. Turn the Power Switch OFF and take step 3.

NOTE: If the trouble "Switched Channels" (that is, went from Channel 1 to Channel 2 or vice versa) the trouble lies in the preamplifier which was plugged into the faulty channel.

NEITHER CHANNEL FUNCTIONING.

If the full sweep cannot be achieved on either channel, do not change the Module Check Chart Entries. Turn the Power Switch OFF and take step 3.

Step 3. (Figures 4-5)

Open the rear panel. Interchange the plugs on the rear of the driver amplifiers. Replace the rear panel, securing it temporarily with a single screw in the top center hole of the panel. Be careful not to let the crossed cables come into contact with the fan blades.

Turn the Power Switch ON and observe the pen motors while rotating the preamplifiers' ZERO controls. Be sure to take careful note of Figure 4-5B, which shows the block diagram of the present module interconnection.

NOTE: Changing plugs at the rear of the driver amplifiers, has in effect electrically switched the driver amplifier-preamplifier combinations, so that the driver amplifier and preamplifier on the left operates the pen motor on the right and the driver amplifier and preamplifier on the right operates the pen motor on the left. We will continue to refer to the driver amplifier-preamplifier combination, physically on the left, as Channel 1, and to the combination on the right as Channel 2.

ONLY ONE CHANNEL IN OPERATION.

If the Channel 1 Pen Motor (left) is sweeping properly, it means that the preamplifier 1 (now in Channel 2) and the Channel 2 Driver Amplifier are functioning. Make any new entries in the Module Check Chart (Figure 4-1). If the pen motor in Channel 2 (right) is functioning, it means that preamplifier 2 (now in Channel 1) and Channel 1 Driver Amplifier are functioning. Make any new entries in the Module Check Chart (Figure 4-1). If necessary to make further determinations, turn the Power Switch OFF and take step 4.

NEITHER CHANNEL FUNCTIONING.

If the full sweep cannot be achieved on either channel, do not change the Module Check Chart entries. Turn the Power Switch OFF and take step 4.

Step 4. (Figure 4-4)

Return the preamplifiers back to the positions they occupied during step 1,

above. Rotate the preamplifiers' ZERO controls while observing the pen motors.

ONLY ONE CHANNEL IN OPERATION.

If Channel 1 Pen Motor is sweeping properly, Preamplifier 2 (now in Channel 2), Driver Amplifier 2 and Pen Motor 1 are functioning. Make any new entries in the Module Check Chart (Figure 4-1). If Channel 2 Pen Motor is sweeping properly, Preamplifier 1 (now in Channel 1), Driver Amplifier 1 and Pen Motor 2 are functioning. Make any new entries in the Module Check Chart (Figure 4-1). If necessary to make final determinations, turn Power Switch OFF and take step 5.

Check items 1, 4, and 5 in step 5, then, observe the completed Module Check Chart (Figure 4-1).

NEITHER CHANNEL FUNCTIONING

If the full sweep cannot be achieved on either channel, do not change the Module Check Chart entries. Turn Power Switch OFF and take step 5.



Fig. 4-6 Removing Driver Amplifier Securing Screws

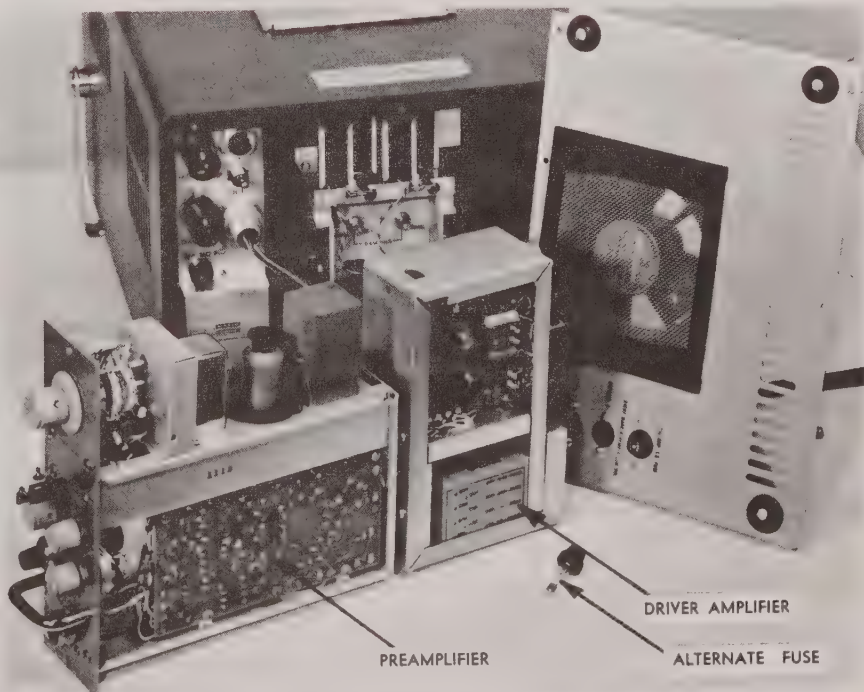


Fig. 4-7 Temporary Driver Amplifier Test Arrangement

Step 5.

Observe the completed Module Check Chart (Figure 4-1). Note which modules are "OK" and which are either "?" or "NG". Repair those which are "NG" according to instructions in the appropriate preamplifier manuals used in your BLH "Meterite".

If, during the Channelizing procedure, it was NOT possible to achieve a working channel (both Channels were out on all tests), make the following checks:

1. Fuses: Re-check the fuses in the rear of each Driver Amplifier (See Figure 4-3).

2. Power Wire and Plug (wall plug). Check to see that wires, plugs and sources are OK.

3. Power Supply (Line) Voltage must be above 105V.

4. Cables: Check that the cables interconnecting the modules are in good condition.

5. Plugs: Check all internal plugs which connect the cables to the modules.

4.4 Localizing and Isolating Troubles in the Model DA-101B Driver Amplifier.

NOTE: These instructions will be limited to the replacement of specific transistors. Components, the replacement of which require the use of a soldering iron have NOT been included, inasmuch as such replacements require component matching using procedures entailing the use of complex technical equipment. When the trouble lies beyond the scope of these instructions, the mal-functioning module (only) should be sent to an authorized BLH repair depot according to instructions in paragraph 4.5.

4.4.1 Specific procedure to localize and isolate faulty transistors.

1. Remove the rear panel. Unplug the faulty channel's preamplifier.

2. Check the fuse in the Driver Amplifier which is in trouble (Figure 4-3).

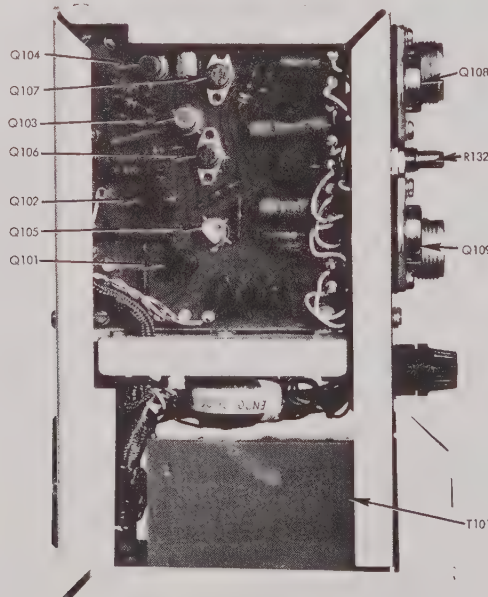


Fig. 4-8 Driver Amplifier Transistor Location

3. Remove the driver amplifier which is in trouble. Use a long narrow screwdriver with which to back off three screws, the heads of which are reached from the front of the "Meterite" as shown in Figure 4-6.

4. Plug the preamplifier into the Driver and arrange these units in a suitable air stream. Figure 4-7 shows the use of the cooling fan on the "Meterite" if no other fan or blower is available. Plug the pen motor cable into the rear of the Driver. When using the "Meterite" during these tests, be sure to remove the fuse at the rear of the remaining Driver Amplifier. (See Figure 4-3.) This prevents the energizing of this channel without available forced air.

5. Turn the Power Switch ON. Keep hands clear of fan.

6. Rotate the ZERO adjust knob on the preamplifier. Observe the action of the pen motor.

NOTE: At this stage, it is important to note the characteristic of the symptom. Note whether or not the pen will go full scale (either left or right). Note whether or not the pen motion can be controlled (and to what degree) by the rotation of the preamplifier ZERO control. See Figure 4-8 for transistor location.

4.4.2 Table 4-1, shows several typical "symptoms" and the transistors which may be the cause. This table is provided to minimize the number of transistor exchanges required. The numbers under a particular transistor, indicate the order in which they should be interchanged. That is, those labeled "1" should be interchanged first, followed by 2, 3, etc. If the symptom changes, the faulty transistor may be isolated by replacing the suspected ones (one at a time) with functioning transistors of the exact type. Those in the al-

ternate driver may be used (temporarily) for this purpose.

4.5 Returning Equipment for Repair.

If, during or after channelizing, localizing and isolation procedures, it is decided that the faulty unit should be returned to BLH for repairs, please follow the instructions in paragraph 4.11.

NOTE: If the equipment warranty period has not expired, be sure to follow these instructions carefully in order to avoid transportation damage which might NOT be included in the warranty.

4.6 Installing the Model PS-200A Electric Writing Power Supply (on Model BSA-250A, only).

The Electric Writing Power Supply, Model PS-200A when installed in the Model BSA-250A converts this "ink-only" instrument to an "ink and electric" writing oscillograph system. Purchased separately, the PS-200A is easily installed in the field by non-technical personnel using simple tools.

4.6.1 Briefly, the installation of the Electric Writing Power Supply consists of securing the main section of the power supply to the bottom of the cabinet between the chart drive guide rails. The terminal strip is then secured to the terminal block. The final step is to replace the monogram plate (on the rear of the top deck) with the Electric Writing Power Supply control panel. This last step requires partial disassembly of the panel prior to installation. The step-by-step procedure is detailed in the following sub-paragraphs.

NOTE: DO NOT remove or detach any wires during this operation.

Table 4-1. Localizing Troubles in the Driver Amplifier, Model DA-101B

(Abbreviations are provided in "Key", below.)

SYMPTOM	TRANSISTORS								
	Q101	Q102	Q103	Q104	Q105	Q106	Q107	Q108	Q109
FL	1	1	2	2	-	3	3	4*	4*
HL	1	1	2	2	-	-	-	-	-
FL-HL	-	-	-	-	-	1	1	-	-
FL to 0	-	-	-	-	-	1	1	2*	2*
FL-HR	-	-	-	-	1**	-	-	-	-
0-FR	-	-	-	-	1**	2	2	3*	3*
HL-FR	-	-	-	-	-	1	1	-	-
HR	-	-	1	1	-	-	-	-	-
FR	1	1	2	2	-	3	3	4*	4*
Slight Offset	-	-	1	1	-	-	-	-	-
No Motion	BLOWN FUSE IN DRIVER, may be caused by preamplifier troubles OR Driver Power Rectifier Diodes. If Model DA-101B is in trouble, return to BLH.								

* Do not replace, return to BLH for repairs.

** Interchange with Q105 in the alternate driver amplifier (Model DA-101B) if no other transistor of exact type is available.

Key:

FL = Full Left (no control)

HL = Half Left (no control)

FL-HL = Full Left to Half Left
(Controllable)

FL-0 = Full Left to Center
(Controllable)

HR = Half Right (no control)

FL-HR = Full Left to Half Right
(Controllable)

0-FR = Center to Full Right
(Controllable)

HL-FR = Half Left to Full Right
(Controllable)

FR = Full Right (no control)

4.6.2 Securing the Main Section to the Cabinet Floor. (Figure 4-10)

CAUTION: Remove the main power cord from the 115 VAC supply.

1. Remove ink cartridges.
2. Remove the back cover from the "Meterite" (seven screws).
3. Turn the unit on its side (to expose the bottom) and then withdraw the chart drive front panel drawer until it reaches the stop (Figure 4-10).
4. Holding the main section of the Electric Writing Power Supply as indicated in Figure 4-10, insert between the chart drive rails and against the bottom of the cabinet.
5. With the screwdriver, insert and tighten four 6/32 screws (supplied). The screws are inserted through the bottom of the cabinet.
6. Return the "Meterite" to the normal operating position, if desired.

4.6.3 Connecting the Power Cable. (Figure 4-11)

1. (The power cable harness is shaped correctly for proper positioning along the bottom corner of the cabinet.) Loosen the first seven (7) terminal board screws (Figure 4-11).

2. Pass the PS-200A cable beneath the chart drive cable (Figure 4-11) removing the cable clamp, if necessary. Then slip the PS-200A cable under the channel 2 driver amplifier cable (Figure 4-11).

3. Slip the spade lugs of the cable terminal strip under corresponding screws of the terminal block.

4. Secure the seven (7) screws loosened in step 1 of this sub-paragraph.

5. Replace the channel 2 driver amplifier cable to a position similar to that shown in Figure 4-11 for the channel 1 driver amplifier cable.

4.6.4 Installing the Electric Writing Power Supply Control Panel.

4.6.4.1 Partial dis-assembly of the Panel (Figure 4-12)

1. Using the Allen type wrench, loosen BOTH set screws on each of the two gray potentiometer knobs.

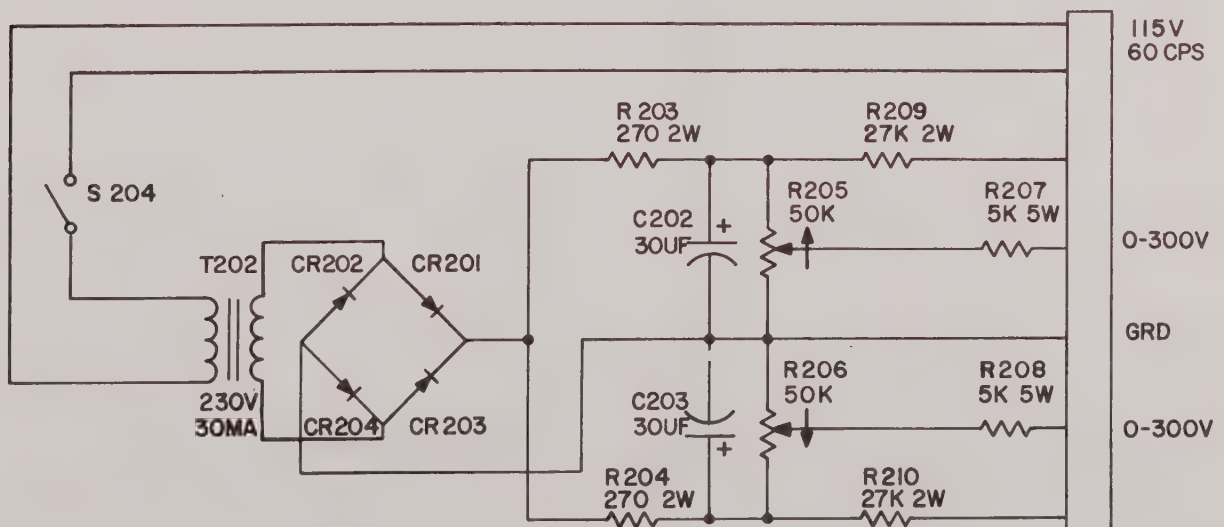


Fig. 4-9A PS-200A Electric Writing Power Supply Schematic Diagram

2. Using the adjustable wrench, remove (and save) the hexagonal nuts on both potentiometer shafts.

3. Separate the potentiometers from the panel.

4. Remove and save the lockwashers.

5. Remove (and discard) the remaining hexagonal nuts on the potentiometer shaft. These were installed for shipping purposes, only.

6. Using adjustable or open end wrench, loosen the hexagonal nut on the toggle switch (beneath the panel).

7. Manually remove (and save) the knurled nut on the end of the toggle switch shaft.

8. Separate the toggle switch from the panel.

4.6.4.2 Re-Assembly and Positioning of the Panel.

1. Position the panel on top of the "Meterite" as shown in Figure 4-13.

2. Pass the shaft of the potentiometer (with the RED wire) through the panel hole marked "CHANNEL 1" (Figure 4-13) and replace both lockwasher and hexagonal nut. Tighten the nut lightly with the fingers.

3. Pass the shaft of the potentiometer with YELLOW wire through the panel hole marked "CHANNEL 2" (Figure 4-13) and replace both lockwasher and hexagonal nut. Tighten the nut lightly with the fingers.

4. Holding the toggle switch in the position indicated by Figure 4-13 with the key notch toward the word "OFF", insert the shaft through the center hole and replace the knurled nut.

NOTE: You may desire to position the knurled nut beneath the panel and the hexagonal nut above, to permit the use of the adjustable wrench as shown in Figure 4-13.

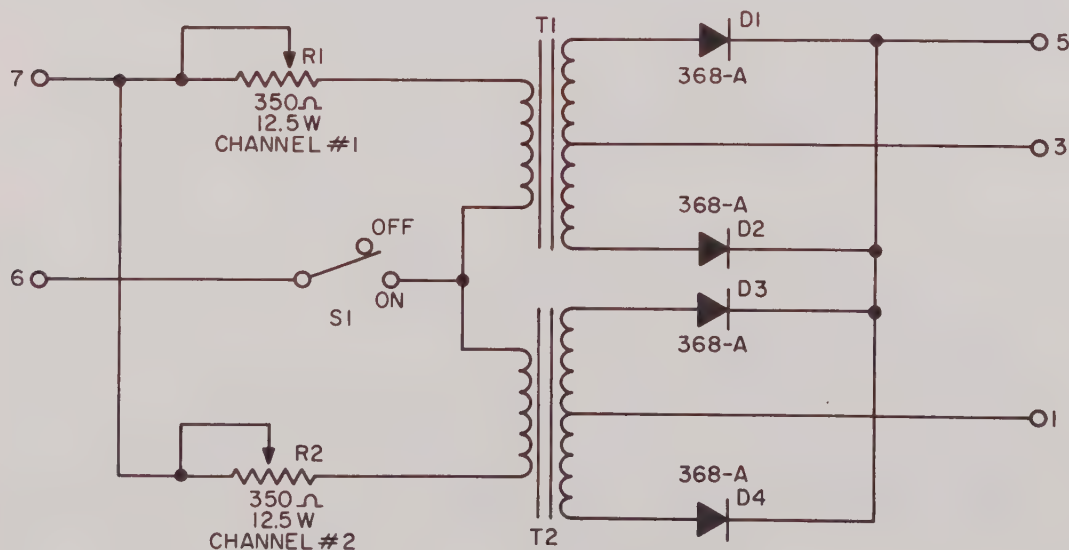


Fig. 4-9B PS-200B Heat Writing Power Supply Schematic Diagram

5. Using the adjustable or open end wrench and holding the panel in correct position, secure the hexagonal nuts on the potentiometers.

6. Rotate each potentiometer shaft to the full COUNTERCLOCKWISE position.

7. Replace the gray potentiometer knobs; rotate until the knob arrow is aligned with the word "MIN" on the scale beneath; then (with the knob skirt clearing the panel) tighten the set screws using the Allen type wrench.

8. Replace the rear "Meterite" panel (seven screws).

4.6.5 Testing the System.

CAUTION: When the electric writing system is energized, the writing and event marking styli are energized with potentials as high as 300 volts DC. DO NOT touch the pen tips when the electric writing system is energized.

NOTE: The electric writing system power switch (top panel) is inoperative when the chart drive system is de-energized.

1. Turn Electric Writing Power Switch OFF; rotate both potentiometers to "MIN".

2. Install a roll of electric writing paper according to instructions in Section 2 of this manual division.

3. Install the electric writing and event marking styli according to instructions in the Pen Motor Division of this manual.

4. Plug the "Meterite" Power Cord into the 115 VAC supply.

5. Put the Chart Speed RANGE switch to LO; set the MM/Sec switch to 5.

6. Turn Electric Writing Power Switch to ON.

7. Rotate Channel 1 potentiometer in the clockwise direction and note the Channel 1 stylus which should begin to write a straight line down the chart.

8. In the meantime BOTH event marking styli should be writing straight lines. The stylus associated with the automatic timer will produce "pips" if the timer switch is on.

9. If, in step 7, Channel 2 stylus begins to write, the potentiometers are in the wrong positions. See sub-paragraph 4.6.4.2, steps 2 and 3.

10. Repeat step 7 using Channel 2 potentiometer.

11. If all pens operate satisfactorily, the system is ready to write electrically. The unit may be returned to ink writing by merely securing the electric pen power supply (power switch OFF); replacing the electric styli (all four) with ink writing pens; and changing back to ink paper.

12. In the event that the pens do not perform correctly and if the above installation procedures have been carried out according to instructions, make voltage measurements (paragraph 4.6.6) to determine if the supply is operating correctly.

4.6.6 Voltage Measurements on the Electric Writing Power Supply.

The Electric Writing Power Supply receives its voltage from the fused input power line of the "Meterite". The current to and from the supply passes through the Terminal Board shown in Figure 4-10. The first seven (7) terminals (number 1 is the rearmost terminal) are associated with this supply. Table 4-3 indicates the normal voltages between these terminals.

Table 4-2 Voltages at Various Terminals of the Electric Writing Power Supply.

RED LEAD TERMINALS						
	1	2	3	4	5	6
7	+340	+340	+340	+340	120AC	120AC
6	+340	+340	+340	+340	120AC	-
5	+340	+340	+340	+340	-	-
4	0	0	0	-	-	-
3	0	0	-	-	-	-
2	0	0	-	-	-	-

A Simpson Multimeter, Model 260 (or equiv.) should be used to make the measurements. The pens should be elevated from the paper. The Electric Writing Power Supply Schematic is provided in Figure 4-9A.

4.7 Installing the Model PS-200B Heat Writing Power Supply (on Model BSA-250B only).

The Heat Writing Power Supply is physically similar to the Electric Writing Power Supply, and is installed using the same procedures. Follow procedures in paragraph 4.6.

4.8 Installing the TK-101A Automatic Take-Up Unit. (Figure 2-5D)

1. Remove the cover plate located on the "Meterite" recorder section pull-out

drawer. This plate is immediately below the RANGE switch.

2. Replace the plate with a similar one (with 4 holes) from the TK-101A kit. Align the holes with matching holes on the panel, beneath. Secure using two retaining clips.

3. Install reel assembly onto the plate using two 8-32 screws which fit into the two smaller threaded holes. Note that the reel assembly must extend horizontally beneath the chart paper exit slot.

4. Now install the threaded pulley onto the mating threaded gear on the left side of the recorder section. The pulley extension should be toward the gear.

5. Pass the spring belt around the threaded pulley then through the two larger holes.

6. The belt is connected together by inserting the tapered end inside the other end. Rotate the tapered end clockwise a turn or two, then counterclockwise. This provides proper holding tension for this left-hand threaded device.

7. Pass the belt around the pulley on the reel assembly. Installation is complete.

NOTE: To remove the TK-101A, reverse the above steps.

Fig. 4-10 Installing the Electric Writing Power Supply

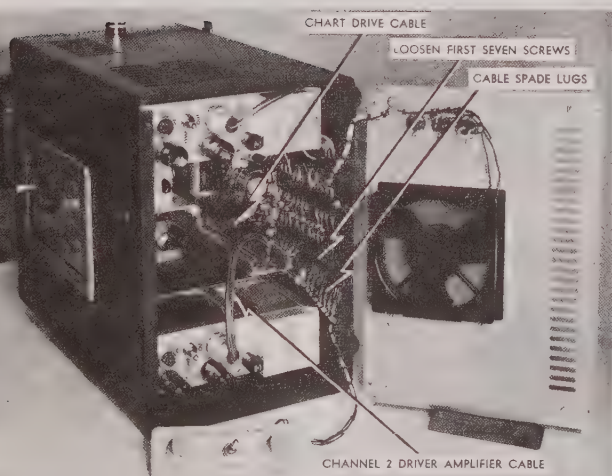
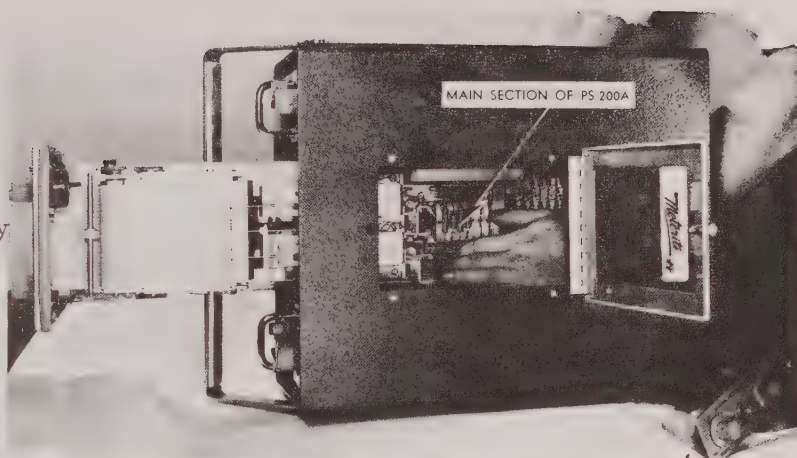


Fig. 4-11 Connecting the Electric Writing Power Supply Cable



Fig. 4-13 Positioning of the Electric Writing Power Supply Panel

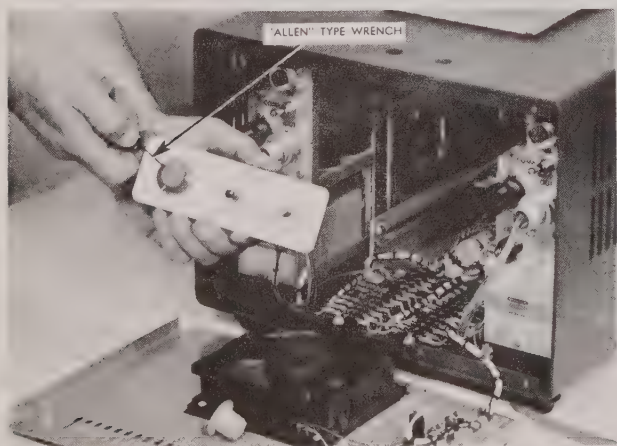


Fig. 4-12 Partial Dis-assembly of Electric Writing Power Supply Panel

Fig. 4-14 Electric Writing Power Supply Model PS-200A



4.9 Installing Automatic Timer.

This optional timer when not factory installed is supplied in kit form to be installed by your own technicians. The installation procedure is simple, since the instrument is pre-wired it is only necessary to connect a few wires to the switch and timer motor. Installation procedures for the event marking pen assembly, to be placed between the chart grids, are given in the Pen Motor Manual.

1. Turn the Meterite upside down and pull out the recorder section drawer as far as it will go. Support the Meterite so that it will not slip.

2. Locate cable clamp holding six open wires on right hand side of chassis.

Remove screw holding cable clamp and remove wires from clamp.

3. Unsolder violet and WH-VIO-BLK wires attached together.

4. Install switch and timer motor using hardware supplied. Be sure to note key way position on switch.

5. Wire switch and timer using color code as shown in Figure 4-15. Be sure to wire the switch with the switch key way positioned as shown.

6. Installation procedures for the event marker assembly are given in the Pen Motor Manual.

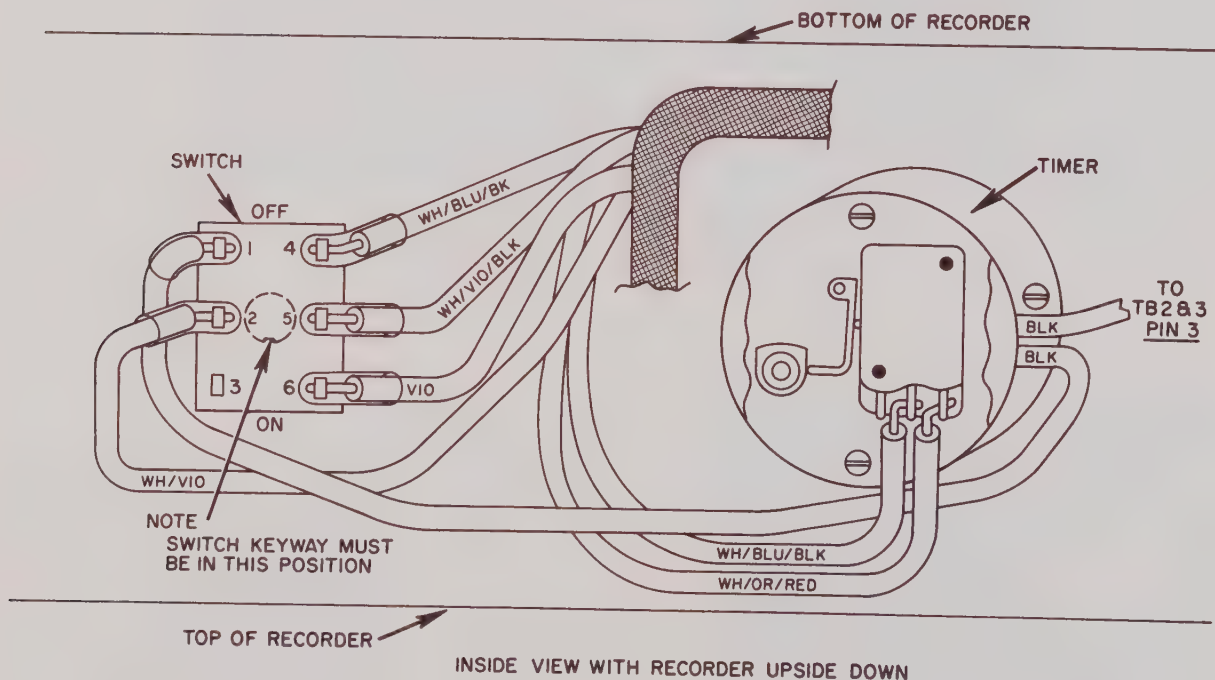


Fig. 4-15 Installing Automatic Timer

4.10 Setting the Driver Amplifier Damping Control for 70% of Critical Damping.

The damping control for the Pen Motor is located on rear of the driver amplifier DA-101B.

The damping procedure consists of balancing and/or calibrating the associated preamplifier. Then, using the preamplifier calibration voltage control, step-voltages are applied and the damping control adjusted until the proper response is obtained. The steps, below, simplify this procedure.

1. Balance and/or calibrate the associated preamplifier.

2. Set the preamplifier Range Switch to a position which will permit the pen to sweep 1 centimeter (10 millimeters) when

the preamplifier calibration voltage control is operated.

3. Center the 1-centimeter sweep using the preamplifier ZERO control. This will cause the pen to sweep 5 millimeters each side of center when the preamplifier calibration voltage control is operated.

4. While alternately operating and releasing the preamplifier calibration voltage control, adjust the pen motor damping potentiometer until the overshoot (spike) at the top of the step-function rise is exactly 0.5 millimeters above the horizontal maximum. Figure 4-16B shows this Peak.

NOTE: Figures 4-16A and 4-16C show the overshoot characteristics for the extremes of the damping control, that is at approximately 30% (CCW) and 110% (CW) of critical damping.

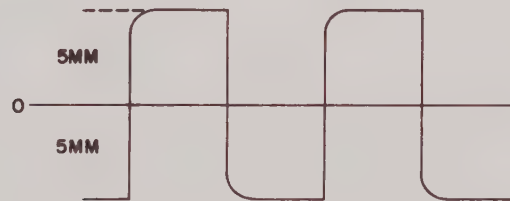


Figure 4-16A Pen Response, Damping Set at 110% of Critical

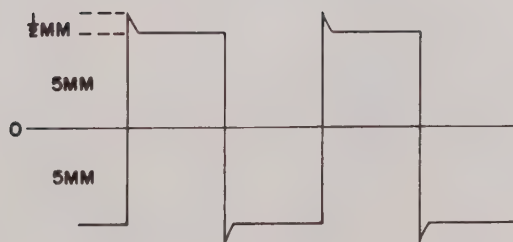


Figure 4-16B Pen Response, Damping Set at 70% of Critical

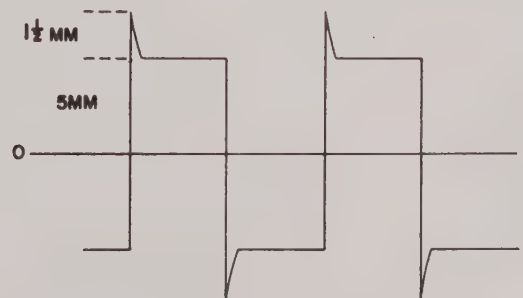


Figure 4-16C Pen Response, Damping Set at 30% of Critical

4.11 Packing for Shipping.

1. Contact BLH Electronics or your nearest authorized BLH Representative. Explain the difficulty so that the Factory or representative may determine the return procedure which will provide the quickest service for you. Generally, the local authorized BLH Representative can remedy the problem without removing the equipment from your plant. In the rare case where it becomes necessary to actually ship the faulty unit, please follow the remaining steps. BLH will rush you instructions as to speedy shipment and insurance requirements. **DO NOT SHIP EQUIPMENT UNTIL THESE INSTRUCTIONS HAVE BEEN RECEIVED BY YOU.**

2. Carefully inspect the unit for loose items. Tubes (and shields) and transistors should be secure in their positions. Ink bottles should be removed to prevent ink spilling during shipment. If it is desired that the ink container be sent along, pack it separately in a waterproof container.

3. If so equipped, the Automatic Chart Take-Up Unit should be removed and stored until the "Meterite" is returned.

4. Pack in a "box within a box" as follows. (See Figure 4-17.)

5. Obtain a shipping container which is sufficiently large to permit one inch of shock absorbing padding surrounding the unit.

Suitable padding materials are:

- A. Shredded Newspaper.
- B. Crumpled Newspaper.
- C. "Kimpak".
- D. Excelsior either wood or paper.
- E. "Rubber Hair".

6. Place the "Meterite" in a bag or wrap with several folds of paper to prevent the material from entering the unit during shipment.

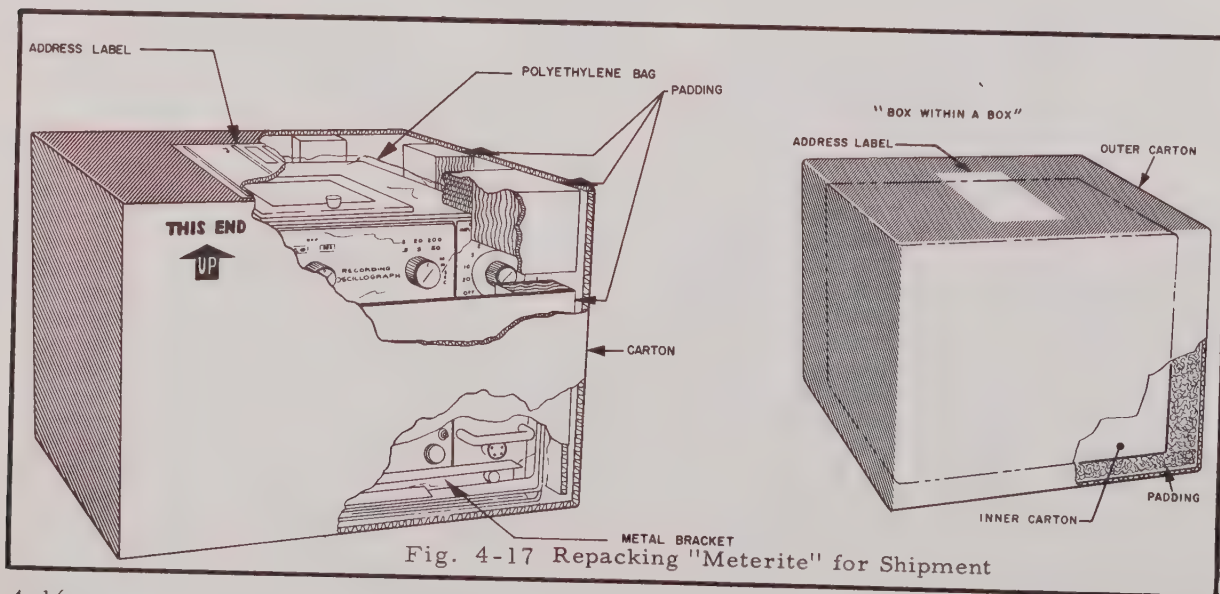
7. Place this container in the larger second container, surrounding the inner box with at least one inch (top, bottom and sides) of the same insulating material.

8. Address the box. Containers of 2 cubic feet or more should have address labels on at least two opposite sides. Also, if shipping the complete "Meterite", be sure to label the top of the shipping container and place arrows pointing upward on the sides of the unit. The arrows should be visible from all angles.

9. If the shipment consists of more than one container, please indicate which portion of the shipment is represented by each box. For example, if two boxes comprise the shipment, mark one "1 of 2" and the second "2 of 2".

10. Be sure to insure the shipment according to the instructions sent by BLH Electronics.

11. The method of shipment depends on the costs involved and is left to the discretion of the owner of the "Meterite".



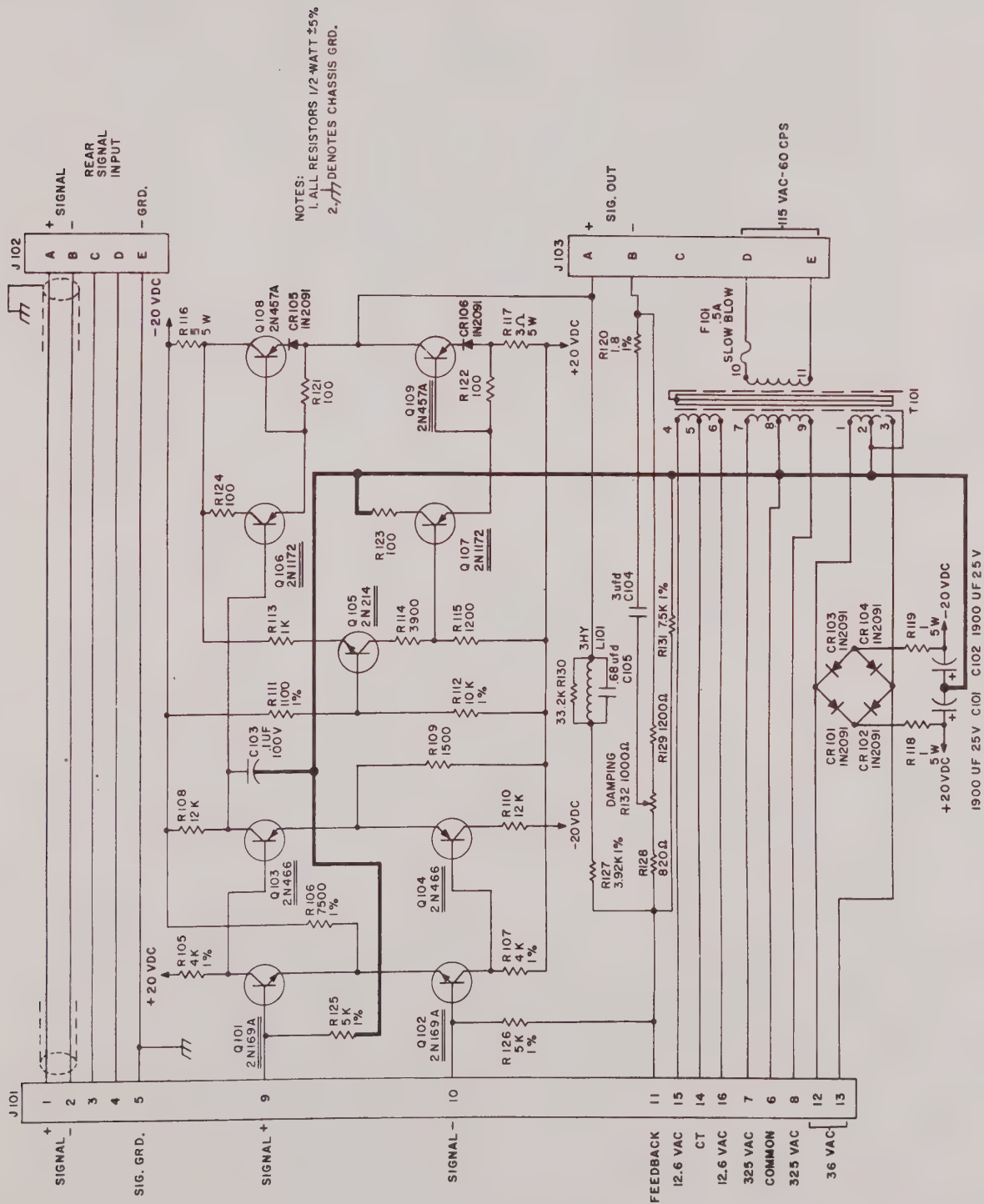


Fig. 4-18 Driver Amplifier Model DA-101B, Schematic Diagram

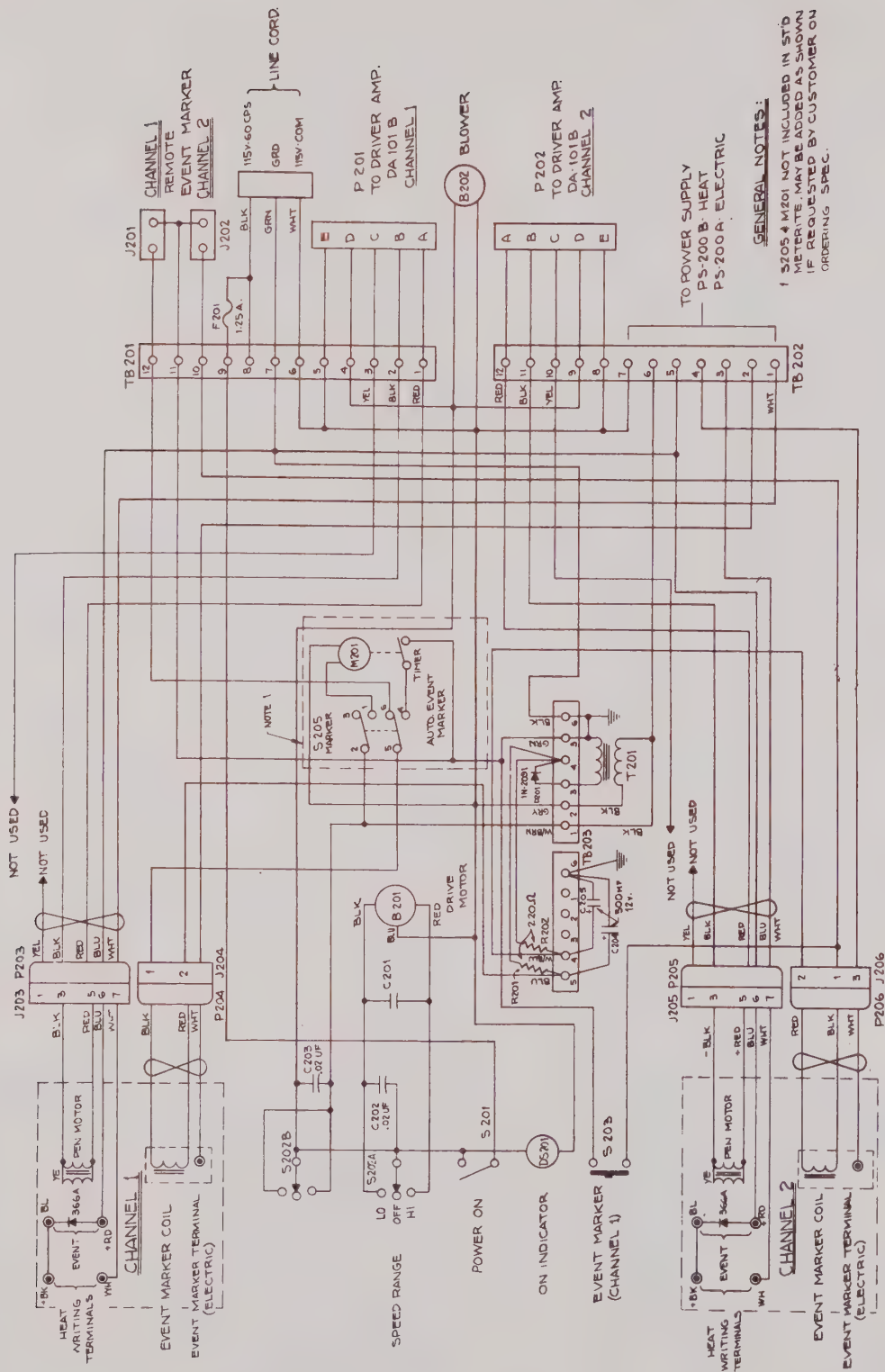


Fig. 4-19 Meterite Schematic Diagram

TABLE 4-3

LIST OF REPLACEABLE PARTS FOR METERITE (LESS DRIVER AMPLIFIERS)

CIRCUIT SYMBOL	DESCRIPTION	MFR. CODE	BLH PART NO.
B201	MOTOR, SYNCHRONOUS 115 V - 150 RPM, 60 cycle	BOD	141714-8
B202	BLOWER, "Muffin", Series 0447	RO	280380-3
C201	CAPACITOR, ELECTROLYTIC Supplied with 141714-8 (Motor)	CD	141713-8
C202, C203	CAPACITOR, Ceramic Disc., ED02 .02 μ FD. 600 Va	ER	133269-8
C204, C205	CAPACITOR, 500 WP, 12 V	ER	135534-8
D201	DIODE 1N2091		140342-8
DS201	INDICATOR ASSEMBLY #1040B16 (white)	IND	140608-8
DS-S202	KNOB for S202 KNOB for SPEED SELECTOR Same as DS-S202 KNOB for PAPER ROLL	MASSA MASSA	280640-1 280640-1
F201	FUSE 1.25A, SB	LIT	128856-8
J201	CONNECTOR, Socket 2 contacts, S-302-AB	CIN	141716-8
J202	Same as J201		
J203	Not applicable		
J204, J206	CONNECTOR, CHASSIS, 3 pin polarized socket, 403BT-5	AP	141495-8
J205	Not applicable		
M201	TIMER, ONE SEC.	BM	141694-8
P201	CONNECTOR, 5 pin socket 97-3106-14S-5S-639	AMH	140497-8
P202	Same as P201		
P203	CONNECTOR, molded 7 pin socket	MASSA	280446-1
P204, P206	Not applicable		
P205	Same as P203		
R201, R202	RESISTOR, COMP. 220 ohms, 1/2 W, 5%	CLA	129837-8

Table 4-3

LIST OF REPLACEABLE PARTS FOR METERITE (LESS DRIVER AMPLIFIERS)

CIRCUIT SYMBOL	DESCRIPTION	MFR. CODE	BLH PART NO.
S201	SWITCH, TOGGLE SPST POWER, #AA252	CAR	141414-8
S202	SWITCH, ROTARY, LO-HI #3243J	MAL	141421-8
S203	SWITCH, PUSHBUTTON EVENT MARKER, #30-1	GRA	280038-1
	NUT for S203, 30-C-1023	GRA	141696-8
S204	Not Applicable		
S205	SWITCH, TOGGLE, TIMER, #8363K7	CH	141419-8
T201	TRANSFORMER, P-6465	CST	141314-8
TB201	TERMINAL BOARD, 600A-12	KE	124872-8
TB202	Same as TB201		
XF201	FUSE HOLDER, 342012	LIT	140351-8

TABLE 4-4.

LIST OF REPLACEABLE PARTS FOR PS-200A

CIRCUIT SYMBOL	DESCRIPTION	MFR. CODE	BLH PART NO.
C201	Not Applicable		
C202	CAPACITOR, ELECTROLYTIC 30 UF, 350 VDC	SPR	141226-8
C203	Same as C202		
CR201	RECTIFIER, SILICON 1N2071/PA071	GI	141326-8
CR202	Same as CR201		
CR203	Same as CR201		
CR204	Same as CR201		
DS201	Not Applicable		

Table 4-4.
LIST OF REPLACEABLE PARTS FOR PS-200A

CIRCUIT SYMBOL	DESCRIPTION	MFR. CODE	BLH PART NO.
DS202	Not Applicable		
DS203	Not Applicable		
DS204	Not Applicable		
DS205	KNOB, SKIRTED for R205, 70-3-2	RAY	140011-8
DS206	Same as DS205		
R201	Not Applicable		
R202	Not Applicable		
R203	RESISTOR, COMP. 270 ohms, 2 watt, 5%	AB	141112-8
R204	Same as R203		
R205	RESISTOR, VARIABLE 50 K, CB5031	OHM	140793-8
R206	Same as R205		
R207	RESISTOR, WW, 5 K, 5 watt, 5%	SPR	140261-8
R208	Same as R207		
R209	RESISTOR, COMP. 27 K, 2 watts, 5%	AB	141135-8
R210	Same as R209		
S201	Not Applicable		
S202	Not Applicable		
S203	Not Applicable		
S204	SWITCH, TOGGLE SPST POWER, 80994BD	AHH	141417-8
T201	Not Applicable		
T202	TRANSFORMER, M4-117	CEN	280199-1
TB201	TERMINAL STRIP	CIN	141525-8

TABLE 4-5.
LIST OF REPLACEABLE PARTS FOR PS-200B

CIRCUIT SYMBOL	DESCRIPTION	MFR. CODE	BLH PART NO.
D1	DIODE, #368-A	WES	142012-8
D2	Same as D1		
D3	Same as D1		
D4	Same as D1		
DS1	KNOB, Skirted for R1, 70-3-2		140011-8
DS2	Same as DS1		
R1	RESISTOR, POTENTIOMETER, 350 ohms, 12.5 W		142017-8
R2	Same as R1		
T1	TRANSFORMER, #8224	AT	281918-1
T2	Same as T1		
TB1	TERMINAL BOARD		141525-8
S1	SWITCH, TOGGLE SPST POWER, 80994BD		141417-8

TABLE 4-6.
LIST OF REPLACEABLE PARTS FOR DA-101B DRIVER AMPLIFIER

CIRCUIT SYMBOL	DESCRIPTION	MFR. CODE	BLH PART NO.
C101	CAPACITOR, ELECTROLYTIC 1900 UF, 25 VDC	CD	140375-8
C102	Same as C101		
C103	CAPACITOR, MYLAR FILM 0.1 UF, 100 VDC	ELE	140159-8
C104	CAPACITOR, Metallized Paper 3 UF, 100 VDC, MI-305E	ELE	140164-8
C105	CAPACITOR, MYLAR FILM .68 UF, 100 VDC	WES	141989-8
CR101	RECTIFIER, 1N2091	MAL	140342-8
CR102	Same as CR101		
CR103	Same as CR101		

TABLE 4-6.
LIST OF REPLACEABLE PARTS FOR DA-101B DRIVER AMPLIFIER (Cont.)

CIRCUIT SYMBOL	DESCRIPTION	MFR. CODE	BLH PART NO.
CR104	Same as CR101		
CR105	Same as CR101		
CR106	Same as CR101		
F101	FUSE, 1/2A SB	LIT	128850-8
J101	CONNECTOR, 26-4200-16S	AMH	A-5958-1
J102	CONNECTOR, 97-3102A-14S-5P 639	AMH	140495-8
J103	CONNECTOR, 97-3102A-14S-5S 639	AMH	140494-8
L101	TOROID, 3 Hy. CHOKE	TRI	140337-8
Q101	TRANSISTOR, 2N169A	GE	140034-8
Q102	Same as Q101		
Q103	TRANSISTOR, 2N466	MOT	140032-8
Q104	Same as Q103		
Q105	TRANSISTOR, 2N214	SYL	140035-8
Q106	TRANSISTOR, 2N1172	DEL	140037-8
Q107	Same as Q106		
Q108	TRANSISTOR, 2N457A	TEX	140038-8
Q109	Same as Q108		
R101	Not applicable		
R102	Not applicable		
R103	Not applicable		
R104	Not applicable		
R105	RESISTOR, CARBON FILM 4 K, 1/2 watt, 1%	PEN	140196-8
R106	RESISTOR, CARBON FILM 7.5 K, 1/2 watt, 1%	PEN	140197-8
R107	Same as R105		
R108	RESISTOR, COMP. 12 K, 1/2 watt, 5%	AB	129879-8

TABLE 4-6
LIST OF REPLACEABLE PARTS FOR DA-101B DRIVER AMPLIFIER (Cont.)

CIRCUIT SYMBOL	DESCRIPTION	MFR. CODE	BLH PART NO.
R109	RESISTOR, COMP. 1.5 K, 1/2 watt, 5%	AB	129857-8
R110	Same as R108		
R111	RESISTOR, CARBON FILM 1.1 K, 1/2 watt, 1%	PEN	140195-8
R112	RESISTOR, CARBON FILM 10 K, 1/2 watt, 1%	PEN	140198-8
R113	RESISTOR, COMP. 1 K, 1/2 watt, 5%	AB	129853-8
R114	RESISTOR, COMP. 3.9 K, 1/2 watt, 5%	AB	129867-8
R115	RESISTOR, COMP. 1.2 K, 1/2 watt, 5%	AB	129855-8
R116	RESISTOR, WW 5 ohms, 5 watt, 3%	SAG	140255-8
R117	RESISTOR, WW 3 ohms, 5 watt, 5%	SPR	140262-8
R118	RESISTOR, WW 1 ohm, 5 watt, 3%	SAG	140257-8
R119	Same as R118		
R120	RESISTOR, WW 1.8 ohms, 1/2 watt, 1%	SAG	141983-8
R121	RESISTOR, COMP. 100 ohms, 1/2 watt, 5%	AB	129829-8
R122	Same as R121		
R123	Same as R121		
R124	Same as R121		
R125	RESISTOR, CARBON FILM 5 K, 1/2 watt, 1%	PEN	140219-8
R126	Same as R125		
R127	RESISTOR, COMP. 3.92 K, 1/2 watt, 1%	AB	129714-8
R128	RESISTOR, COMP. 820 ohms, 1/2 watt 5%		129851-8

TABLE 4-6.
LIST OF REPLACEABLE PARTS FOR DA-101B DRIVER AMPLIFIER (Cont.)

CIRCUIT SYMBOL	DESCRIPTION	MFR. CODE	BLH PART NO.
R129	RESISTOR, COMP. 1200 ohms 1/2 watt 5%		129855-8
R130	RESISTOR, COMP 33.2 K, 1/2 watt 1%		129736-8
R131	RESISTOR, COMP. 7.5 K ohms 1/2 watt 1%		129721-8
R132	RESISTOR, POTENTIOMETER 1000 ohms, 2 watt 10%		142005-8
T101	TRANSFORMER	LFE	280006-2
XF101	FUSE RETAINER, #342012	LIT	140351-8

TABLE 4-7.
LIST OF REPLACEABLE PARTS FOR TAKE-UP UNIT
MODEL TK-101A (Fig. 2-5D)

DESCRIPTION	MFR. CODE	BLH PART NO.
ESCUTCHEON PLATE (Replacement Cover Plate)	BLH	280162-2
PULLEY, Threaded	BLH	280160-1
BELT, Spring	BLH	141440-8
FLANGE ASSEMBLY (Retaining Discs)	BLH	281933-1
TUBE, Paper (Located between Discs)	BLH	280166-1
Complete TAKE-UP ASSEMBLY for METERITE	BLH	280158-3

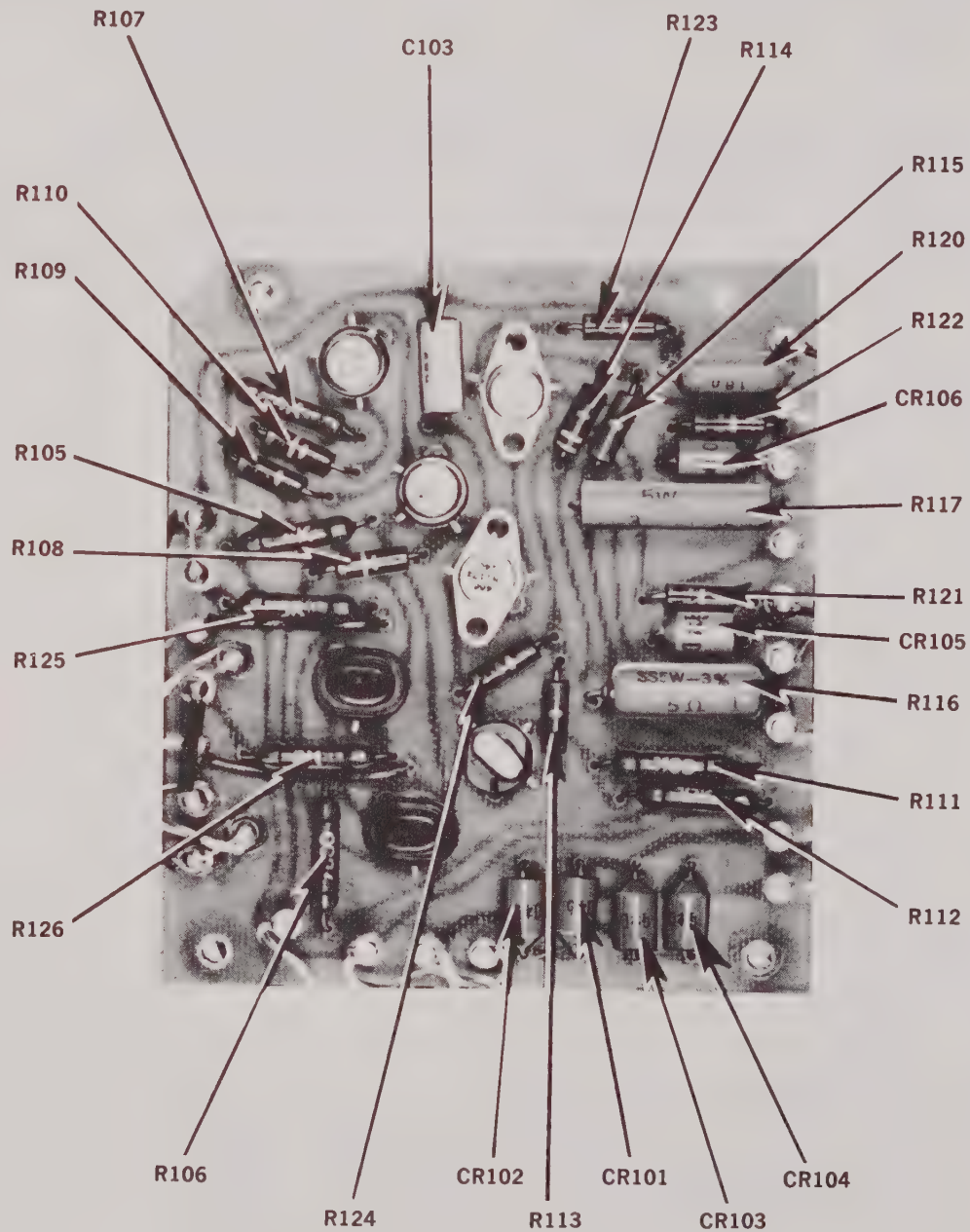


Fig. 4-20A Driver Amplifier, Model DA-101B Circuit Board

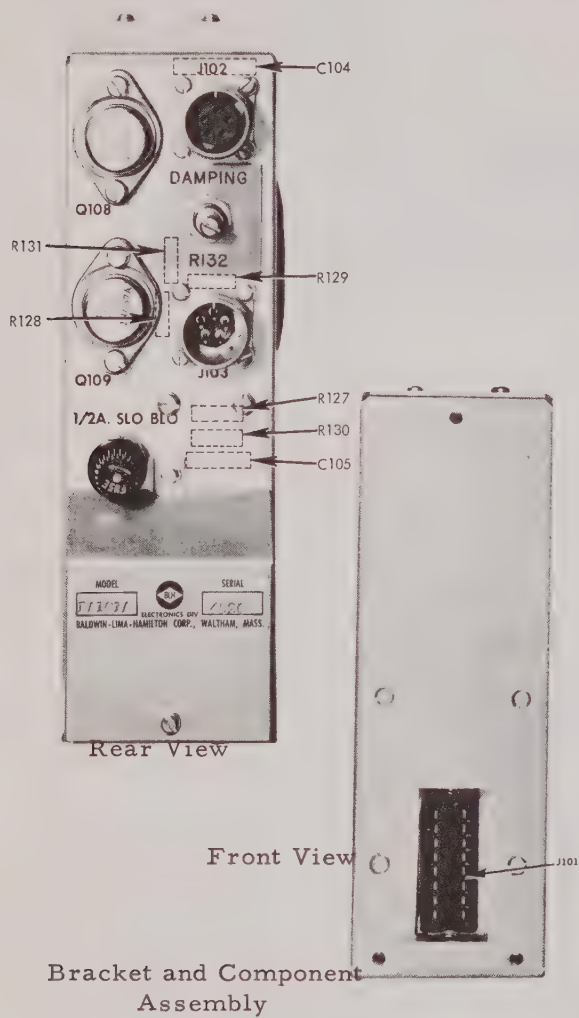


Fig. 4-20B Driver Amplifier,
Model DA-101B

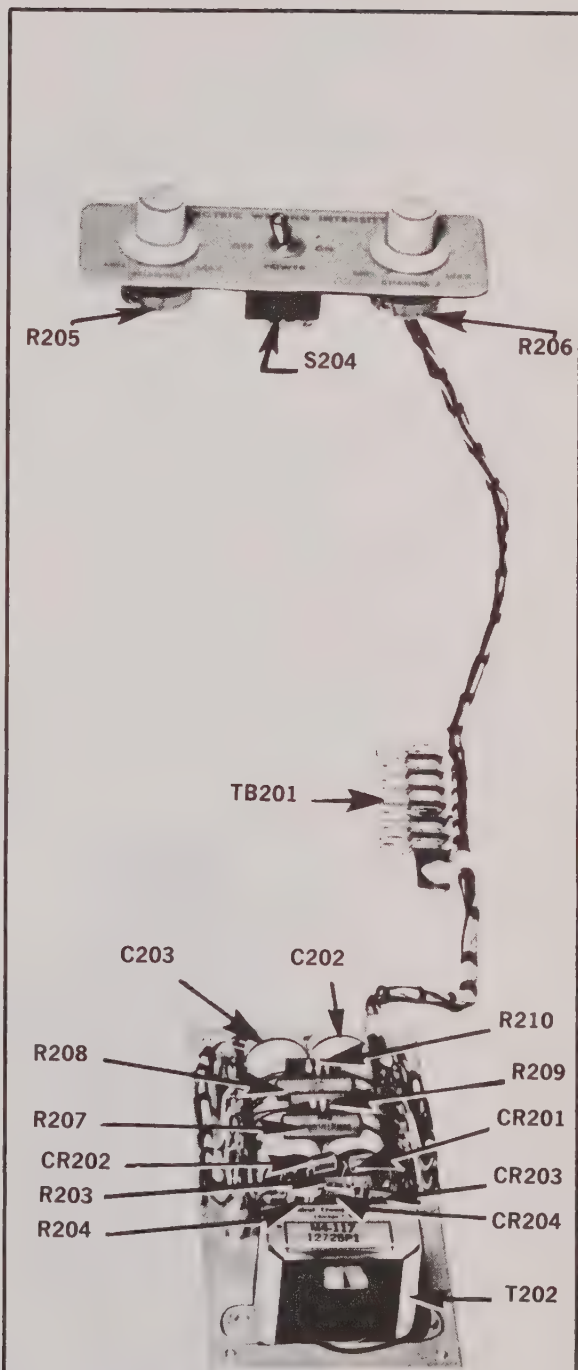


Fig. 4-21 Electric Writing Power Supply
and Panel, Model PS-200A

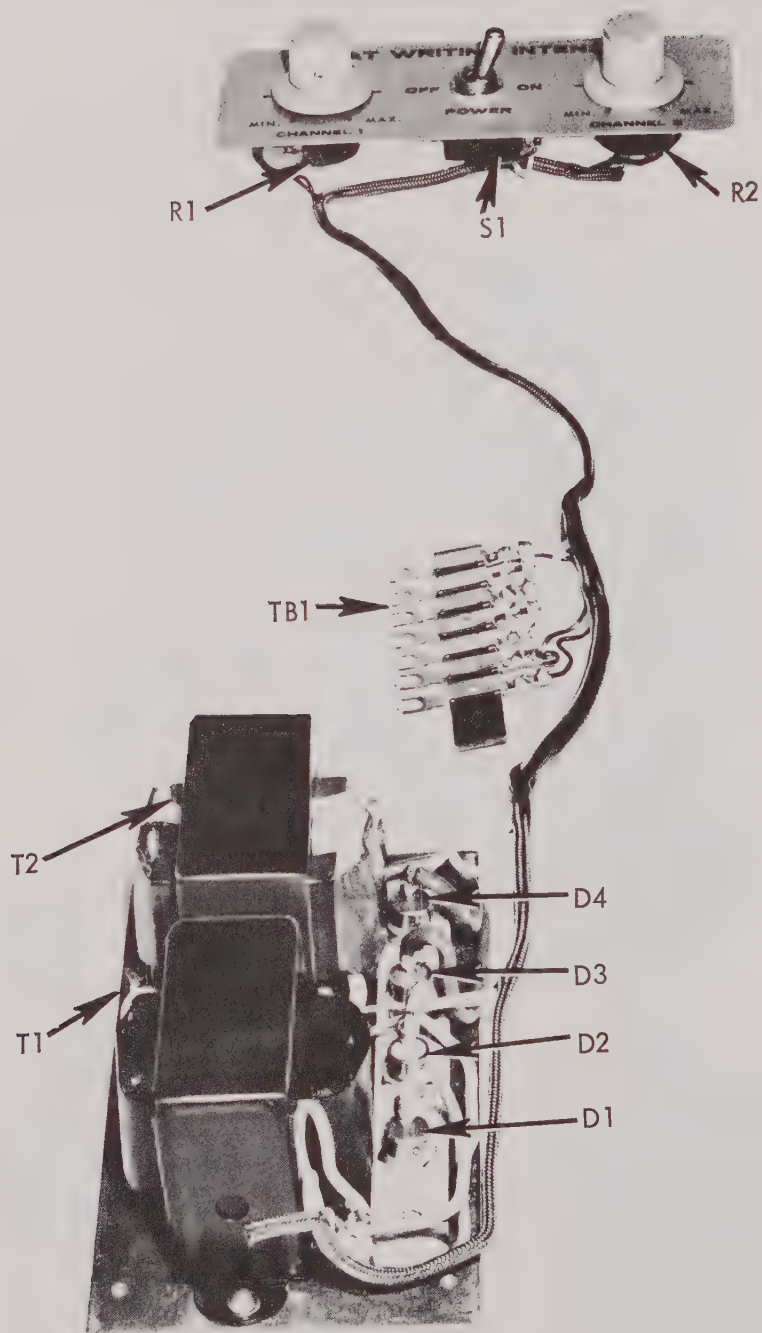


Fig. 4-22 Heat Writing Power Supply and Panel, Model PS-200B

MANUFACTURERS' CODE DESIGNATIONS

CODE	MANUFACTURER	CODE	MANUFACTURER
AB	Allen-Bradley Co.	GEN	General Cement
ADE	Adel Precision Products, Div. General Metals Corporation	GI	General Instrument Corporation, Semiconductor Div.
AER	Aerovox Corp.	GR	General Radio Co.
AHH	Arrow-Hart & Hegeman Elec. Co.	GRA	Grayhill, Inc.
AMH	Amphenol Connector Div., Amphenol-Borg Electronics Corp.	HEL	Helipot Division, Beckman Instruments
AP	Alden Products Co.	IND	Industrial Devices, Inc.
AT	Atlas Eng. Corp.	JA	James Electronics, Inc.
BM	Bristol Motors, Div. of Vocaline Co. of America	KE	Kulka Electric Corp.
BO	Bourns, Inc.	KK	Kurz-Kasch, Inc.
BOD	Bodine Electric Co.	LC	Leecraft Mfg. Co.
CAM	Cambion (Cambridge Thermionic Corp.)	LFE	Lab for Electronics, Inc.
CAR	Carling Electric, Inc.	LIT	Littelfuse, Inc.
CD	Cornell-Dubilier Electronics Div., Federal Pacific Electric Co.	MAL	P. R. Mallory & Co., Inc.
CEN	Central Transformer Co.	MAR	Markel, L. Frank & Sons
CEP	Cherry Electrical Prod. Corp.	MOT	Motorola Semiconductor Products, Inc.
CH	Cutler & Hammer, Inc.	NOB	Nobeloy (Continental-Wirt Electronics Corp.)
CI	Circuit Instruments Div., Int'l. Resistance Co.	OHM	Ohmite Manufacturing Company
CIN	Cinch Mfg. Co., Howard B. Jones Div.	PEN	Penn Resistor Corp.
CLA	Clarostat Mfg. Co., Inc.	PB	Potter & Brumfield
CRL	Centralab Electronics Div., Globe Union	RAY	Raytheon Company
CST	Chicago Standard Transformer Corp.	RCA	Radio Corporation of America
CTS	Chicago Telephone Supply Corp.	RO	Rotron Manufacturing Co.
DAL	Dale Electronics, Inc. Hathaway Inst. Inc.	SAG	Sage Electronics Corp.
DIA	Dialight Corp.	SAR	Sarkes Tarzian, Inc.
DC	Dow Corning Corp.	SPE	Spectrol Electronics
DEL	Delco Radio	SPR	Sprague Electric Company
ELE	Electron Products, Div. Marshall Industries	SW	Switchcraft, Inc.
ER	Erie Resistor Corp.	SYL	Sylvania Electric Products
FR	Freed Transformer Co., Inc.	TEX	Texas Instruments, Inc.
GA	Grigsby-Allison	TL	Tel-Labs, Inc.
GE	General Electric Co.	TRA	Transitron Electronic Corp.
		TRI	Triad Transformer Corp.
		TRO	Trox Corporation
		UT	United Transformer Corp.
		WES	Wesco Electrical Co.

INSTRUCTION MANUAL
FOR
MODEL OS-700
PEN MOTORS

Designed and Manufactured by



BLH ELECTRONICS, INC.

A subsidiary of Baldwin • Lima • Hamilton Corporation
WALTHAM, MASSACHUSETTS 02154 • (617) 894-6700

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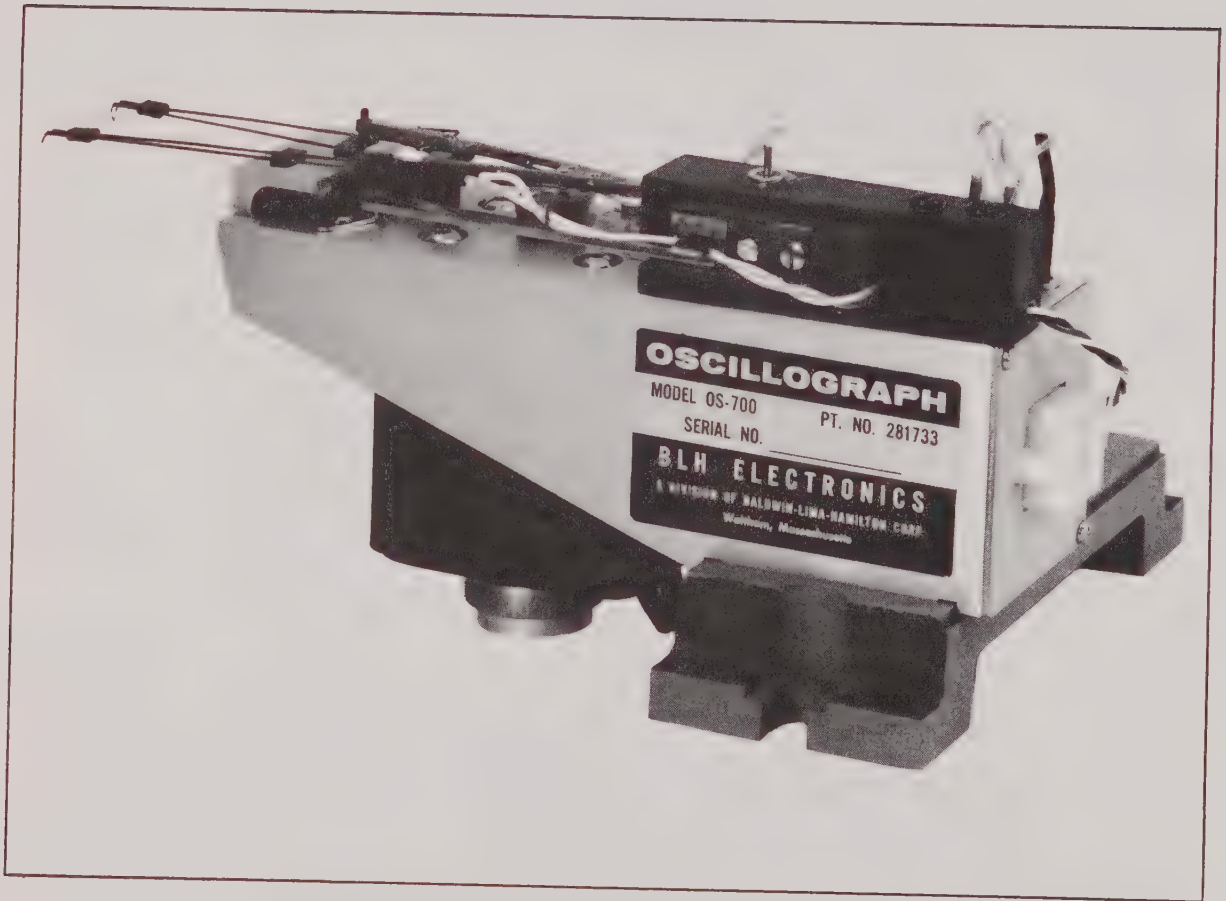


Figure 1-1. Model OS-700 Pen Motors

Section 1

INTRODUCTION

1.1 General.

This manual covers the description, unpacking, installation, theory of operation and adjustments for the BLH Direct Writing Pen Motor Model OS-700, Figure 1-1. These high speed, direct writing pen motors record electrical signals on moving chart paper and consist of an electrodynamic movement, a unique rectilinear linkage and a special pen.

1.2 Description.

Model OS-700 Pen Motors have a total pen amplitude of 40 millimeters and are made to use ink or thermotip writing styli. The pen motors are provided with a universal micrometer adjustment for alignment along the X axis, making possible precise alignment with the chart paper coordinates. Model designations and serial numbers are located on the side of the pen motor frame.

1.2.1 Event Markers.

Event markers are available on BLH Pen Motors when ordered. The event marker is used to record time and/or specific events and is operated by a coil energized either by an internal timing circuit or by front-panel and/or remote switches under the manual control of the operator or external switches. When energized, the coil causes the event marking pen to produce a timing spike or event marking trace on the chart between the central recording charts. Specifications for the event marker will be found in Paragraph 1.6. Installation instructions for event marking pens will be found in Section 2, paragraphs 2.4.1 and 2.4.2.

1.2.2 Damping.

Electrical damping is provided in the BLH Rectilinear Pen Motor when used with Model DA-101B Driver Amplifier. This damping improves response by reducing distortion and overshoot. See Section 3, Theory of Operation, for details.

1.2.3 Mounting Bases.

BLH Pen Motors are block mounted. Pen Motor installation instructions are found in paragraph 2.3 of Section 2.

1.2.4 Pen Holders

The recording pen is secured by a special spring clip on the pivot point of the pen frame. A special beryllium copper lever-type spring holds the event marking pen in the yoke.

1.3 Rectilinear Writing.

The BLH Pen Motor writes directly on chart paper having rectangular grid lines, rather than the conventional curved grid lines normally associated with oscillographs. Blank paper is also available. Rectilinear or Cartesian co-ordinates permit the waveform to be reproduced in a more natural form for easy interpretation. You may rely on the waveform slopes reproduced by the BLH Recorder. These slopes may be measured with standard protractors, straight edges and scales.

The principles behind the rectilinear writing BLH Pen Motor are explained in Section 3.

1.4 Styli.

As mentioned in paragraph 1.2, above, BLH Pen Motors may be equipped with either ink or thermotip styli (pens). Fine or coarse writing pens are available by specifying the appropriate jeweled tips.

Plastic tubing transmits ink from the non-spill cartridge to the ink writing pen tips. The thermotip styli have plastic encased copper wires with spring type electrical connectors. These connectors fit the standard terminal on all BLH Pen Motors.

1.5 Applications for BLH Pen Motors.

BLH Pen Motors are intended for general purpose direct-writing recording of electrical signals and may be installed in BLH Recording Systems or special systems made by other manufacturers.

Simultaneous signals may be fed to two or more pen motors and read on accurately printed charts. The pen motor may be used with data logging equipment, analog computers or with any other systems where written records of signals within the frequency range of DC to 200 cycles per second are required.

1.6 Specifications

Maximum Undistorted
Amplitude (millimeters)
Peak-to-Peak

0-40 cps = 40 mm
0-80 cps = 20 mm
0-120 cps = 10 mm

Frequency Response at
Quarter Scale (peak to
peak)

Not more than -3 db
down at 120 cps.

Natural Frequency (cps)

50 - 55

Damping

Total damping set at 70% at BLH

Linearity Hysteresis (combined effect)

0.5% of full scale

Current Sensitivity (MA/MM)

26

Nominal Coil Resistance

6 ohms

*Response Time (Damping Set at 70%
of Critical)

5 MS

Styli

Ink Writing Types

Fine Tip: 0.2 mm trace
Coarse Tip: 0.3 mm trace

Ink (All Models)

Thermotip Writing

Black, brown, green, blue,
purple (in sealed disposable
cartridges to insure clean ink
with constant viscosity pro-
tected from evaporation).

Applicable BLH Recording System

"Meterite"
BSA 450 Series
BSA 650 Series
BSA 850 Series

Sweep Width (Millimeters)

40

Event Marker

Optional

*Response time is time required for pen to deflect from 10% to 90% of its full amplitude.

Section 2

OPERATION

2.1 General.

This section describes the unpacking, packing, preliminary inspection procedures and then details the installation and operation of the BLH Pen Motors.

CAUTION: PLEASE DO NOT attempt to energize or align this instrument until this section has been read and understood. To do so may cause damage, the repairs of which may not be covered in the warranty.

2.2 Unpacking, Packing and Inspection.

The instrument is shipped in cardboard containers (box within a box fashion) and is isolated from normal shipping shocks by suitable shock absorbing materials.

2.2.1 Unpacking Instructions.

Slit the outside tapes, being careful not to cut too deeply. Open the box flaps and remove the cardboard flat and the technical manual beneath. Remove the inner carton from the outer carton. Slit the outside tapes on the inner box, open the box flaps and remove the front and rear separators. Gently lift the instrument from the container. Carefully clip the tape which secures the plastic bag surrounding the instrument. Place the instrument on a convenient surface for visual inspection per instructions in the next paragraph. Retrieve the pens.

NOTE: It is suggested that the shipping container, and the separators be saved for possible future shipment of the instrument to another point or to the BLH Factory for service should this be necessary.

2.2.2 Packing the Pen Motor for Shipment.

If the original shipping container, its shock absorbing materials and sectioning flats have been saved, the pen motor may be packed easily and shipped by any ordinary commercial transportation facility or by mail. If the original shipping container has been discarded, the instrument may be packed according to instructions below. Do not return equipment before advising BLH Electronics.

NOTE: If you return the pen motor to BLH Electronics during the warranty period, be sure to follow these instructions carefully to avoid transportation damage which might NOT be included in the warranty. Contact BLH Electronics or your nearest authorized BLH Representative. Explain the difficulty so that the Factory or Representative may determine the return procedure which will provide the quickest service for you. BLH will rush you instructions as to speedy shipment and insurance requirements. **DO NOT SHIP EQUIPMENT UNTIL THESE INSTRUCTIONS HAVE BEEN RECEIVED BY YOU.**

1. Remove and store both the ink cartridge and pen assembly.

2. Pack the pen motor in containers using the "box within a box" (Figure 2-1) procedure.

3. Obtain a shipping container which is sufficiently large to permit one inch of shock absorbing padding to surround the unit.

4. Place the Pen Motor in a bag to prevent the padding material from entering the unit during shipment. Suitable

padding materials are:

- A. Shredded Newspaper.
- B. Crumpled Newspaper.
- C. "Kimpak".
- D. Excelsior, either wood or paper.
- E. "Rubber Hair".

5. Insert the bag in a container.

6. Place this first container in a larger box, surrounding the inner box with at least 1 inch (top, bottom and sides) of the same isolating material.

7. Address the box. Containers of 2 cubic feet or more should have address labels on at least two opposite sides.

8. Be sure to insure the shipment according to instructions sent by BLH Electronics. See note, above.

9. The method of shipment depends on the costs involved and the urgency of the shipment.

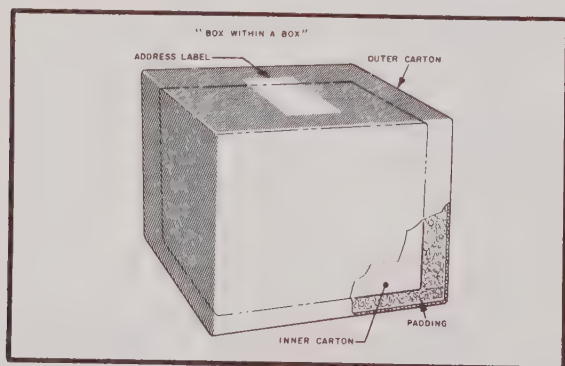


Figure 2-1
Repacking Pen Motors for Shipment

2.2.3 Inspection after Shipment.

Reasonable care has been taken to pack the BLH Pen Motor in a manner such that it will reach you in perfect operating condition. However, to be sure that the instrument will function correctly, check to see that it has not been damaged. There should be no dents, cracks, or

breaks in the case. With the pen motor held in the hand, it should be possible to manually (gently) displace the writing mechanism from left to right, and when released, it should come smoothly and quickly back to the center position. There should be no roughness in the motion.

2.3 Installing the BLH Pen Motor.

When purchased as part of BLH Recording Equipment, the pen motor arrives already installed and ready to operate.

When purchased separately as a replacement or for special recording systems, follow the installation procedure as described below.

In general it is best to observe the installation in the original BLH Equipment and replace the pen motor in exactly the same manner. The instructions which follow facilitate the installation.

To replace the pen motor take the following steps:

1. Unplug the recorder.
2. Remove the ink cartridge, pen assembly and unplug all electrical connectors. See paragraphs 2.4.1 and 2.5.
3. Unscrew the lock screw until the pen motor is free.
4. Remove the old pen motor.
5. Install the replacement unit and tighten the lock screw.
6. Install the pen assembly and the ink cartridge as described in paragraphs 2.4.1 and 2.5 of this section.
7. If necessary, prime the pen.

Lateral alignment procedure is described in paragraph 2.6.

2.4 Installing and Removing Writing Styli.

Two different style pens are used for each of the two modes of writing, analog styli and event marker styli. Procedures are given below for each style pen.

2.4.1 Installing and Removing Analog Styli.

1. Unplug Recorder.
2. Take new pen, squeeze retaining spring (figure 2-2).
3. Position the pen near pivot between tracks and slip pen over guide pin (figure 2-3).
4. Push pen assembly down, gently. Release retaining spring and connect wiring or ink feed tubes (figure 2-4).
5. To remove the pen reverse the above steps.

2.4.2 Installing and Removing Event Marker Styli.

1. Unplug Recorder.

2. With the L-shaped pen tip pointing downward toward the paper, hold the pen barrel (ink, figure 2-5) or pen A-frame (heat, figure 2-6) between the thumb and third finger.

3. Place the pen trunnion against the yoke and with the forefinger gently press down on the pen barrel (ink, figure 2-5) or pen A-frame (heat, figure 2-6) until the trunnion rests against the rear of the yoke.

4. Release the pen barrel (ink) or pen A-frame (heat). The flat pen carriage spring will lift the trunnion until it locks securely in the yoke.

5. Route the ink tube or wires between the vertical posts, under the clip, and through the event marker assembly.

6. Heat styli - connect color coded wires to the RD and GN pen motor terminals.

Ink styli - insert ink feed needle into the event marker ink cartridge.

7. To remove the styli reverse the above steps.

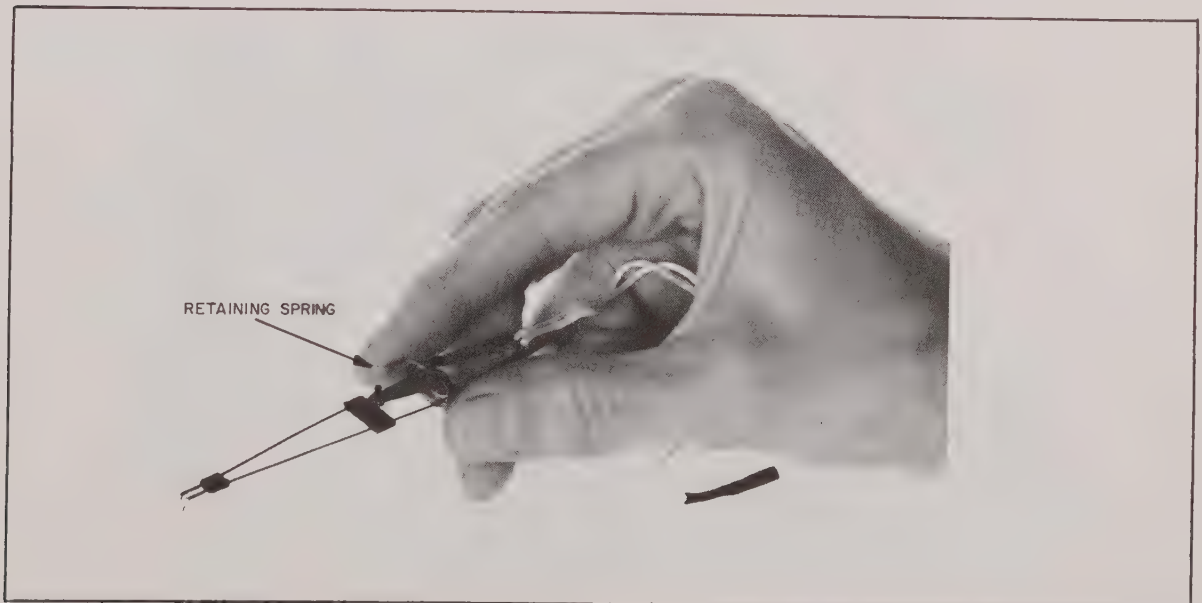


Figure 2-2. Installing and Removing Analog Style, Step 2.

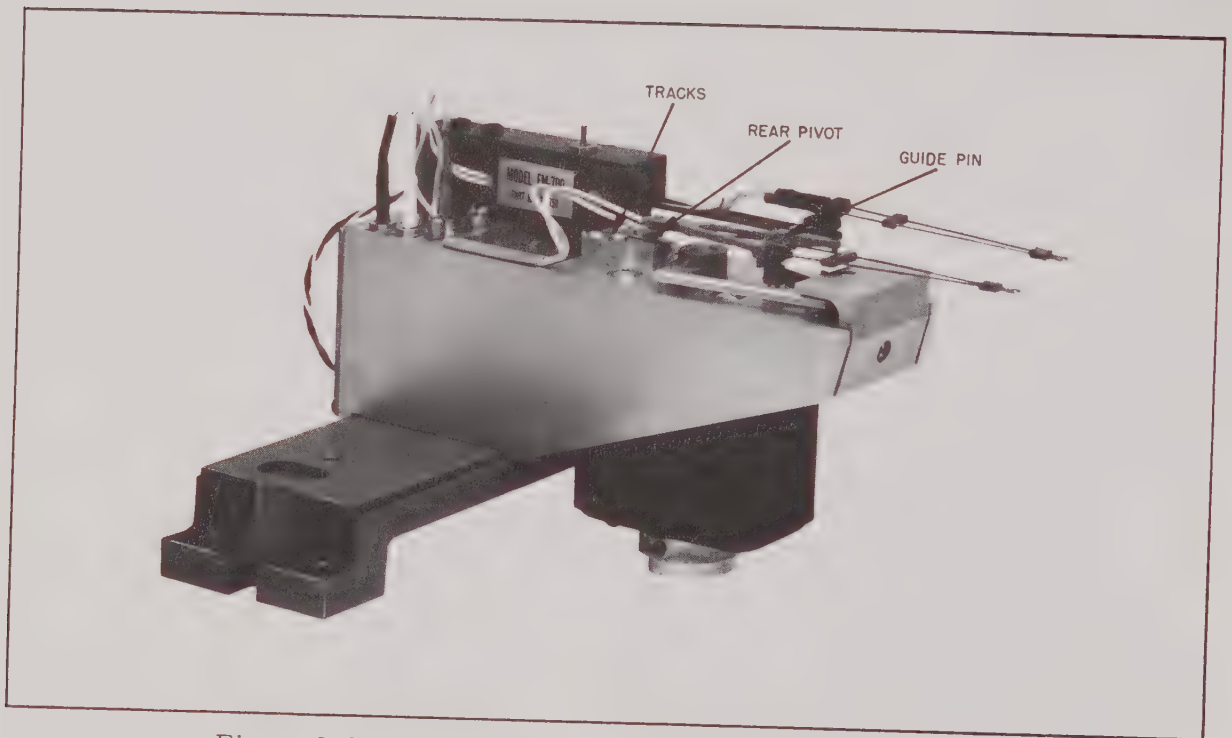


Figure 2-3. Installing and Removing Analog Style, Step 3

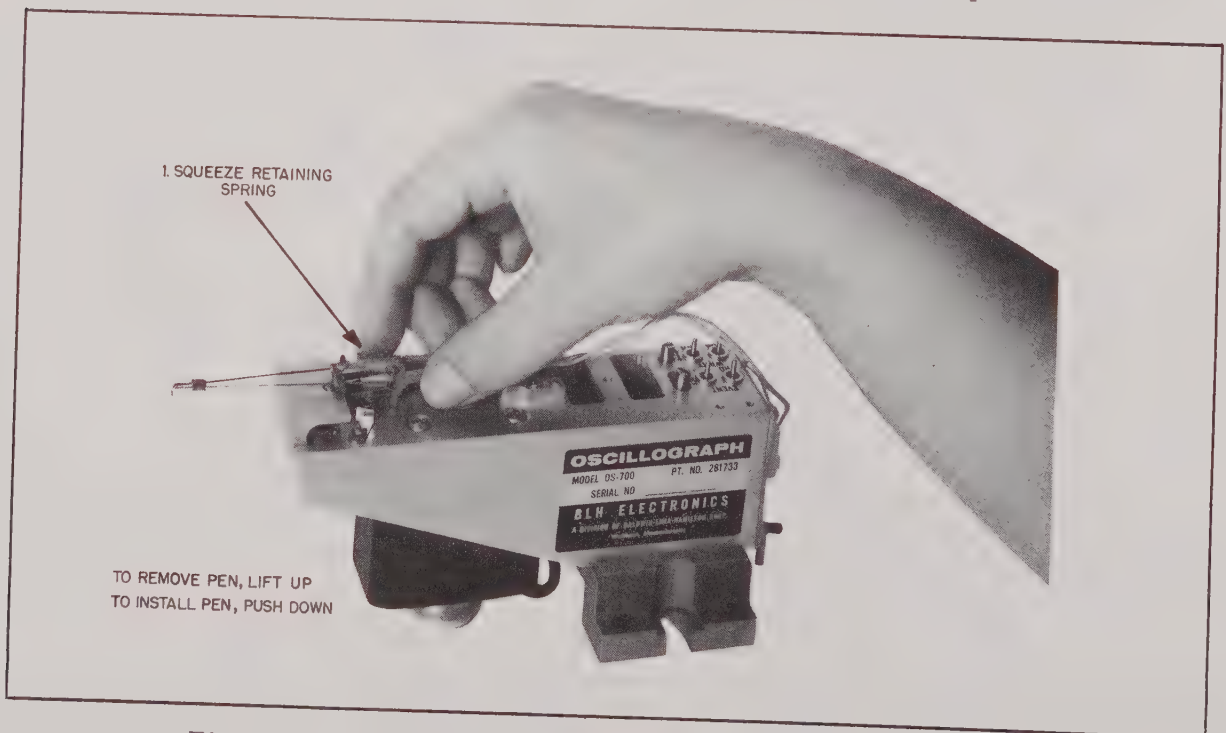


Figure 2-4. Installing and Removing Analog Style, Step 4

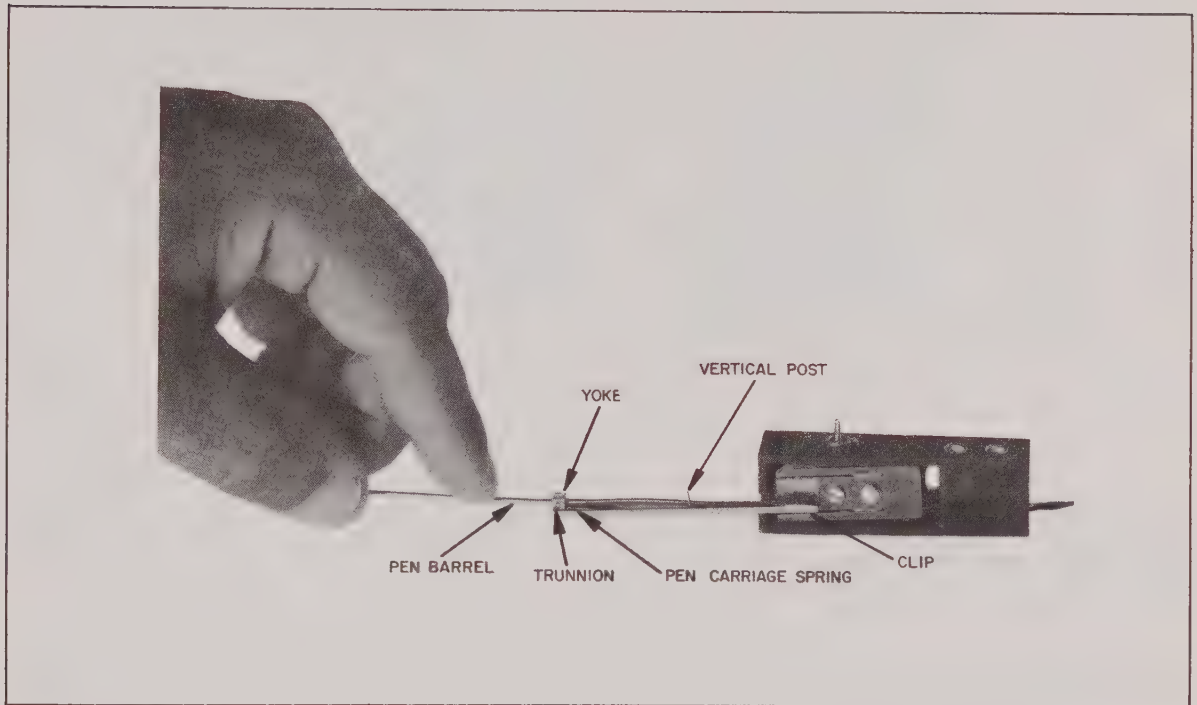


Figure 2-5. Installing and Removing Ink Event Marker Style, Steps 2 and 3

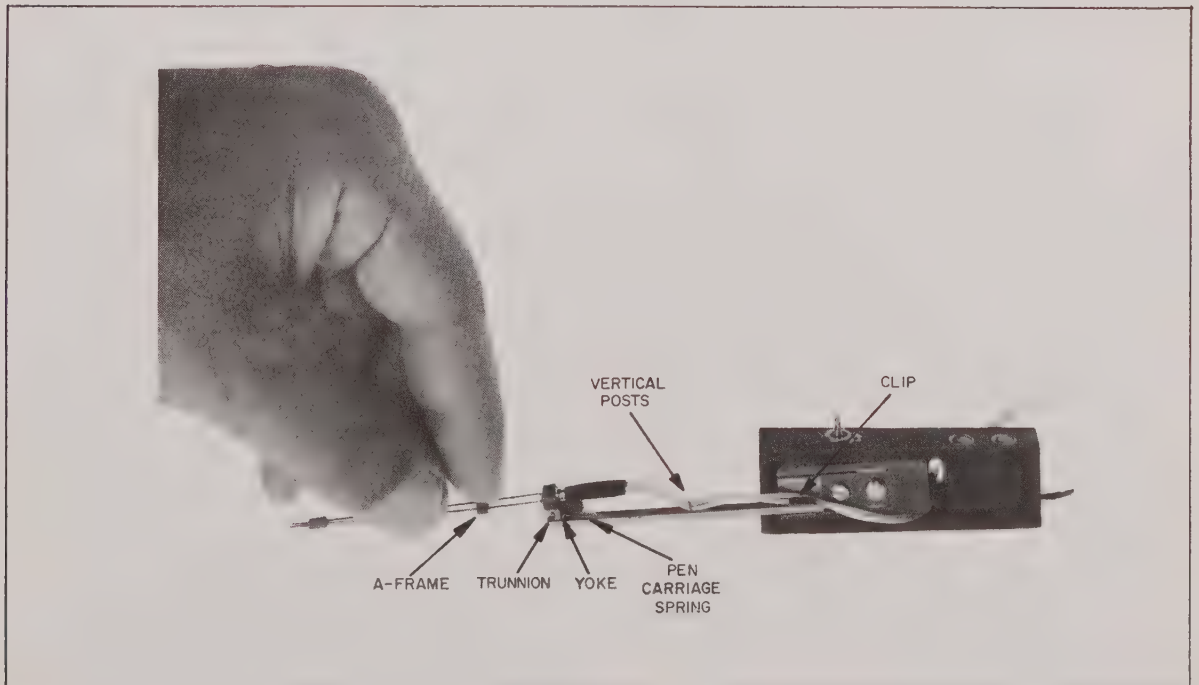


Figure 2-6. Installing and Removing Heat Event Marker Style, Steps 2 and 3

2.5 Installing Event Marker Assembly.

1. Position Event Marker Assembly over screw holes on rear of pen motor.

2. Insert screws and fasten to pen motor.

3. Tighten one of the two screws, rotate assembly until pen is on proper chart location. Tighten other screw.

4. Connect Event Marker plug to proper jack located on rear of Recorder drawer.

2.6 Ink Cartridge Installation.

1. Seat the ink cartridge in the support clip on top of the pen motor. The cartridge must rest against the bottom stop of the support clip or ink may flow and "puddle" on the chart paper.

2. Remove the rubber cap from the tip of the tilted plastic tube on the ink cartridge. Save the cap.

3. Puncture the rubber cap on the vertical cartridge tube with the ink feed needle on the end of the flexible tube.

4. Start the recorder and chart drive and set the speed at 2 mm/sec. (See specific instructions in the recorder manual.)

5. Place the priming bulb point inside the tip of the tilted plastic tube on the ink cartridge. Squeeze gently several times until ink fills the feeder line to the pen tip. A special priming bulb is provided with each Recorder. Your Local BLH representative has replacement bulbs.

NOTE: Once the pen is initially primed, future priming may be accomplished by pressing the 60 cps prime button located on the front panel of the preamplifier. ALWAYS leave the pen tip resting on the chart paper when not in use. This prevents the drying of the ink in the pen tip.

2.7 Pen Motor Alignment.

CAUTION: Except for the aligning adjustments described in the following paragraphs, figures and tables, no attempt should be made to alter the settings on the pen motors. All coated screws are factory adjusted and should not be tampered with. Adjustment of these red coated screws may void the warranty.

2.7.1 Aligning Pen Motors.

When a pen motor leaves the factory, all the adjustments are accurately pre-set. However, in shipment or over a long period of time, the zero positions of the pens may shift somewhat. When this is observed, the pen motors may be adjusted to bring the pen tip into precise alignment on the roll chart.

Parallel and longitudinal alignment are factory set adjustments. The only variable is the lateral alignment which is accomplished by using the screwdriver adjustment on the top rear of the pen motor.

2.7.1.2 Lateral Alignment.

1. To check lateral alignment, turn signal circuit OFF or remove plug from pen motor. Set chart drive to a slow speed and observe pen position.

2. If the pen does not rest on the center of the chart as in condition 1, figure 2-7, follow the steps below.

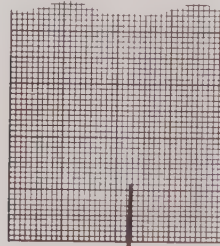
3. Loosen the LOCK screw.

4. Using a screwdriver, rotate the adjust screw in desired direction until the pen appears as in condition 2, figure 2-7.

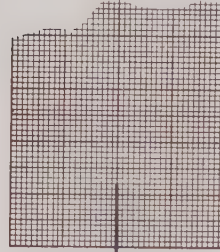
5. Tighten the LOCK screw.

NOTE: When adjustments have been completed according to the instructions above, be sure to run the chart through the recorder at a slow speed for a few seconds to confirm the adjustment under operating conditions.

Condition 1
Incorrect Lateral Alignment
(Adjustment Required)



Condition 2
Correct Lateral Alignment



↔
DIRECTION OF
ADJUSTMENT

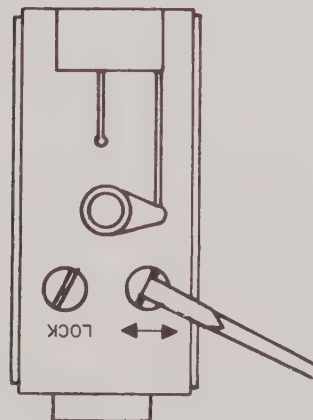


Figure 2-7. Lateral Alignment

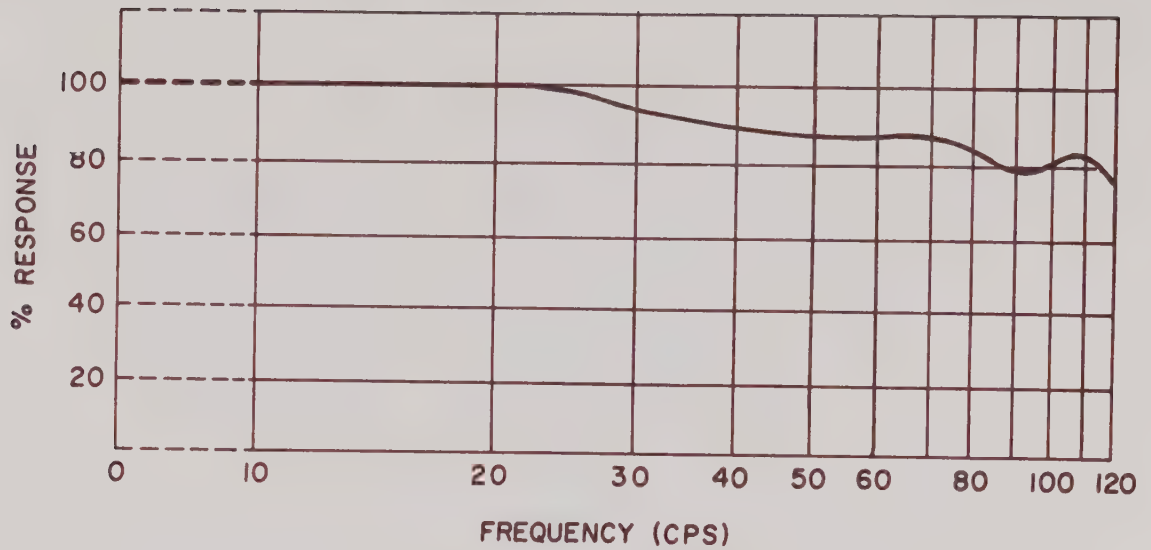


Figure 2-8A. Typical Frequency Response OS-700 Pen Motor

*With Driver Amplifier , DA101B , pen deflection @ ± 5 mm.

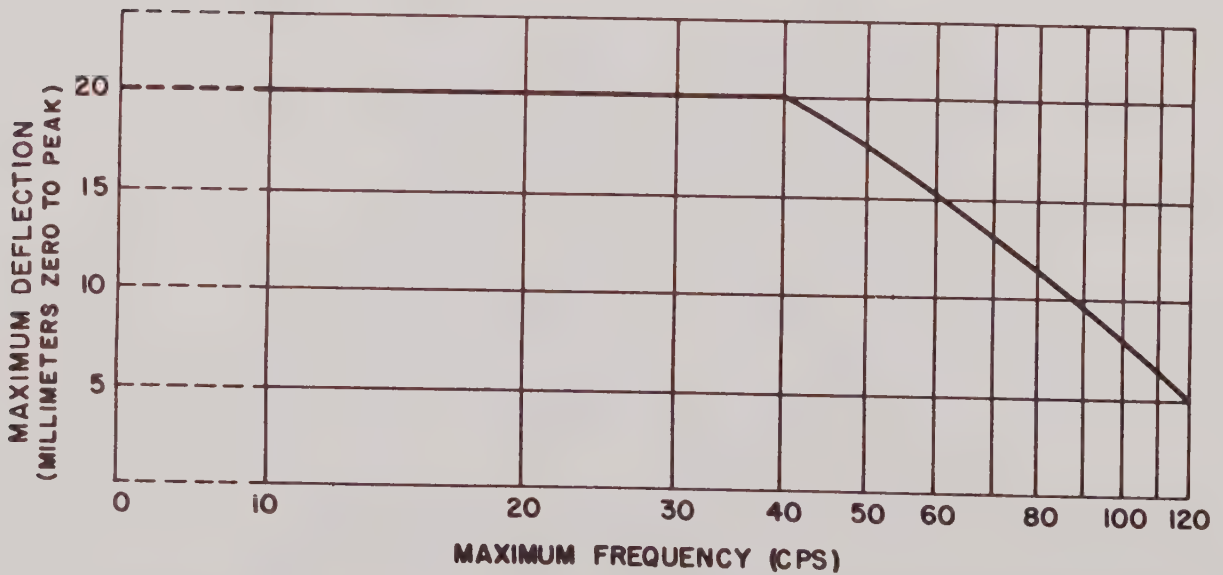


Figure 2-8B. Maximum Pen Deflection for Maximum Recorded Frequency (OS-700 Pen Motor)

2.8 Damping Control.

In BLH Recorders a screwdriver adjustment located on the rear of Driver Amplifier DA-101B, permits setting a potentiometer to control the pen motor damping. By rotating the screw slot fully counterclockwise, 30% of critical damping is reached; by rotating the screw slot fully clockwise, 110% of critical damping results. Any percent of damping between the two can be attained by adjusting this control.

CAUTION: BLH Pen Motors are set at 70% of critical during manufacture. All frequency response specifications are based on this setting. If the pen motor damping control is adjusted for any reason, be sure to return it to 70% (see Section 4, paragraph 4.3.1) before making recording runs which rely on specified recorder frequency response characteristics.

2.9 Frequency Response Considerations.

The frequency compensation network in the DA-101B driver amplifier augments the overall amplifier response at high frequencies (over 40 cps). With the frequency compensation the amplifier will permit the recording of signals as high as 120 cps.

Caution should be exercised, however, to adjust the peak pen motor sweep according to data obtained from Table 2-1 or Figure 2-8. Instructions for the use of tables and graphs are given below. When the peak sweep adjustment is correctly made, the specified response will be correct for the frequency range of interest.

TABLE 2-1 MAXIMUM AMPLITUDES VS. FREQUENCY RANGE

Maximum Amplitude Setting	Maximum Frequency Range
± 20 mm	DC to 40 cps
± 10 mm	DC to 80 cps
± 5 mm	DC to 120 cps

Find the frequency of interest on Table 2-1. If the work is not critical, use the peak amplitude given in the table. If, however, the recorded data is to be analyzed critically, use the graphs in Figure 2-8 and follow the steps below.

1. Locate the frequency of interest on the horizontal scales of both graphs in Figure 2-8.

2. On the Frequency Response graph, find the maximum response for the frequency of interest.

3. On the Frequency Response graph find the intersection of the curve and the vertical percent scale. Read the percentage at this intersection.

4. On the Maximum Pen Deflection graph find the intersection of the curve and the vertical millimeter scale. Read the millimeters at this intersection.

5. Multiply the percentage (Step 3) by the millimeters (Step 4). Record this number of millimeters.

6. Apply a signal equal to the frequency of interest to the preamplifier. The amplitude of applied signal should correspond to that from the transducer or signal source to be used. In fact, the ideal test would be to use the actual transducer or signal source whenever possible.

7. Adjust the preamplifier range switch until the pen sweep is equal to or less than the number of millimeters calculated in Step 5. The amplitude of the input signal may be adjusted to bring the pen amplitude to exactly the calculated value.

If the above steps have been followed, the pen motor response (from DC to the frequency of interest) now corresponds to the frequency response curve used.

Notice, however, that if the maximum frequency of interest response curve is 100% or above 100%, the pen may swing the full 40 millimeters peak-to-peak.

After the recording run has been completed, knowledge of the response will permit precise analysis of the actual signal amplitude sweep.

Section 3

THEORY OF OPERATION

3.1 General.

All BLH Oscillograph Units (Pen Motors) reproduce electrical signals on rectangular graph paper using either ink, electric, or thermotip writing pens or styli. Figure 3-1 shows a typical

oscillogram produced by BLH Pen Motors. Since rectangular co-ordinate chart paper is used, the recorded waveforms have familiar shapes which may be analyzed without the tedious interpretation normally required of the "skewed" recordings taken on conventional "curvilinear" devices.

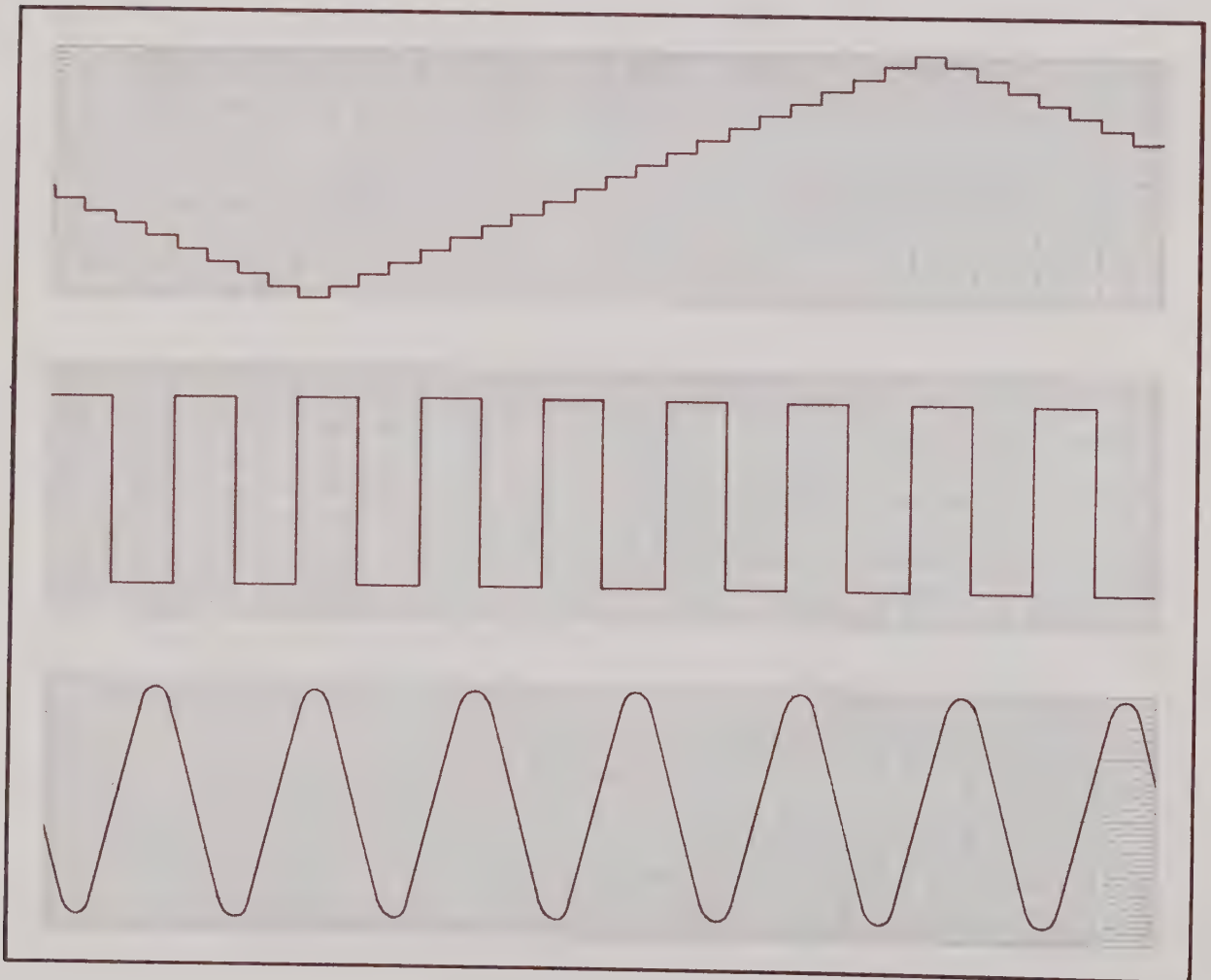


Figure 3-1 Typical Oscillograms Made on BLH Strip Chart Recording Systems

3.2 Mechanical Theory.

3.2.1 Rectilinear Action.

The rectilinear action in BLH Pen Motors is achieved by a movement which guides the sweeping pen tip along a straight line rather than along an arc. Figure 3-2 shows the operating principal. Basically, the movement extends the pen arm forward as the pen moves from center toward one side. This extension is governed by the mechanism to exactly cancel out any tendency for the pen to sweep along an arc.

Figure 3-2A shows a photo of the mechanism while Figure 3-2B provides a schematic sketch. A pivoted pen drive

lever moves the pen in response to the undulating action of the electro-dynamic movement. As the lever swings back and forth, it actually causes the pen to move in two directions at the same time. One motion is across the chart (from position 2 to 1, back through 2 to 3, etc.). The second motion causes the pen pivot to slide in and out (right and left as shown on the page) between two guide pins. These combined motions produce a straight line pen motion across the chart.

Figure 3-2C shows the pen extended to position 1 (one edge). The pen, represented by the "dash-dot" line, is positioned so that its pivot end is far forward toward the front of the guide pins.

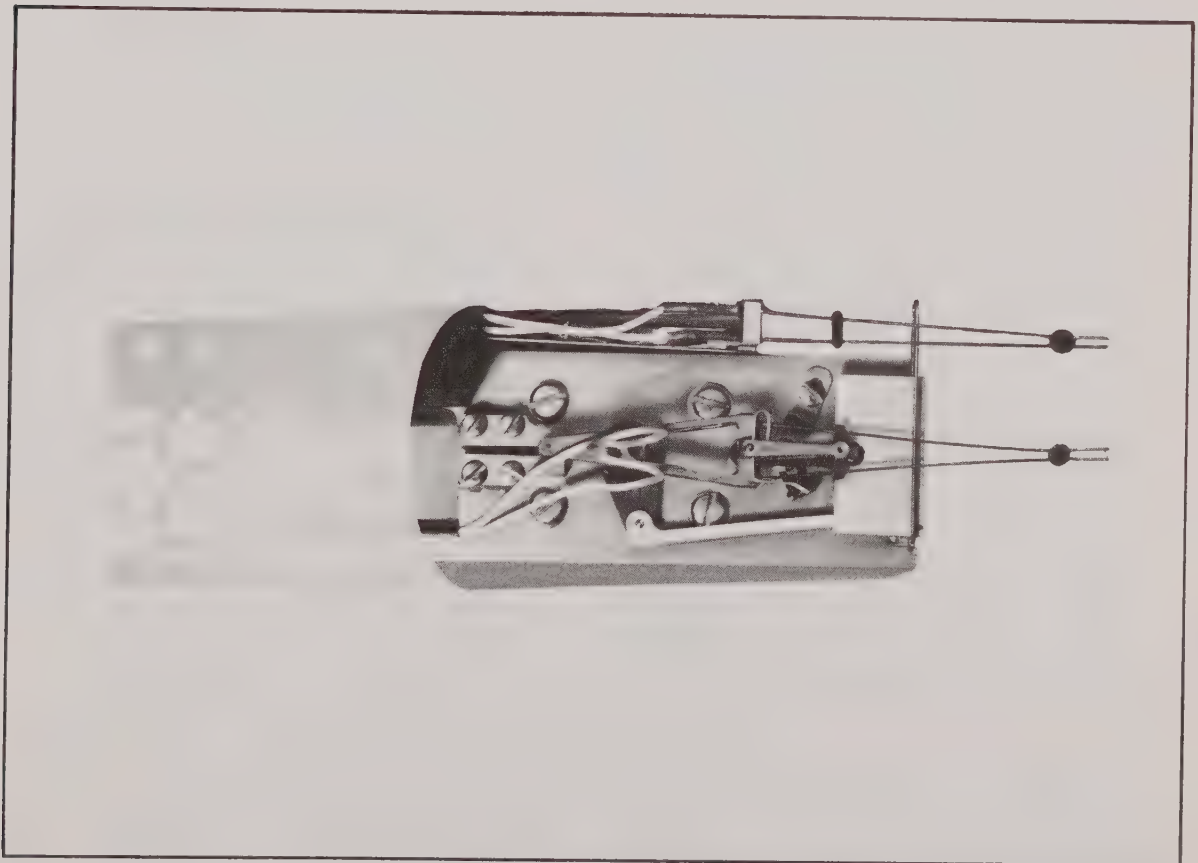
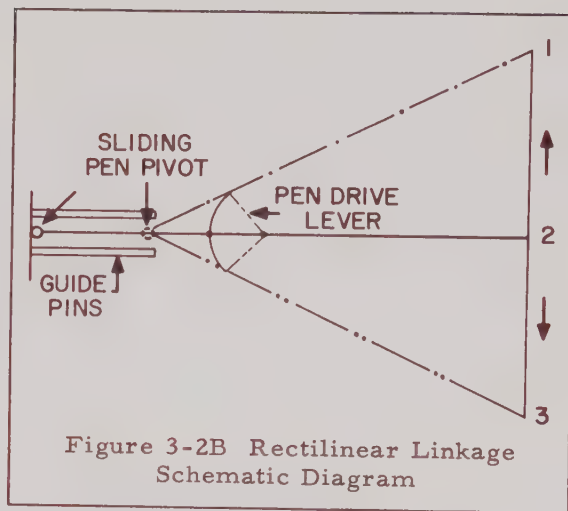


Figure 3-2A BLH Pen Motor Rectilinear Linkage

Note also that the pen drive lever is pointing to one side.

In Figure 3-2D, the pen has moved from position 1, to position 2 (center of chart) and is represented by a solid line. Now, the pen pivot is near the rear of the guide pins and the pivoting drive lever is now under the pen, and pointing toward the rear of the mechanism.

Finally, in Figure 3-2E, the pen is shown as a dotted line at the opposite side of the chart. Once again the pen pivot is near the front of the guide pins but now the pendrive lever is extended to the other side.

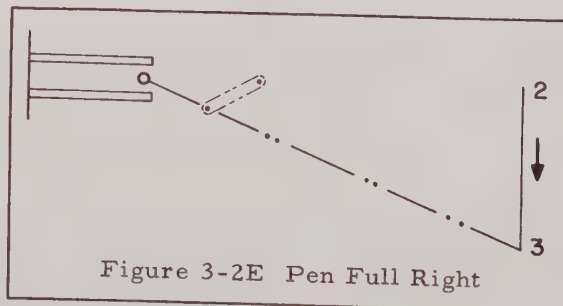
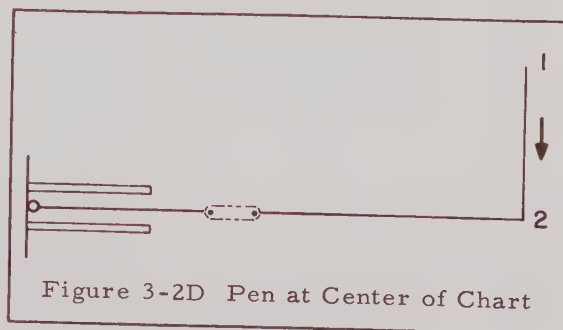
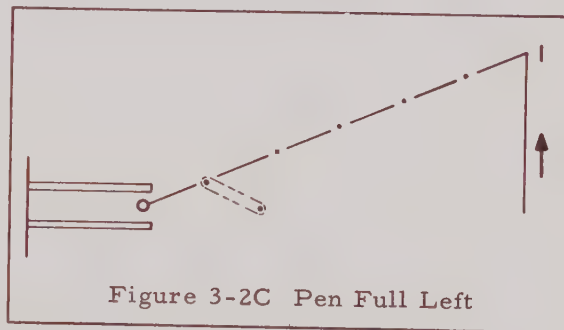


3.2.1.1 The Advantages of Rectilinear Pen Motor Action.

The immediate advantages of such a writing characteristic may not be too apparent. Figures 3-3 through 3-5 show three groups of waveforms which help focus on the importance of this type of pen drive movement.

Figure 3-3A shows square waves reproduced by a BLH Rectilinear Writing Pen Motor. In Figure 3-3B, the same signal is shown recorded by a so-called "curvilinear" pen motor. Note that in Figure 3-3A, the square waves are, in fact, "square" while in Figure 3-3B, they are curved. Note also that the graph paper in Figure 3-3B is curved to compensate for this inherent "skewing" of the conventional pen motor movement. Although the data on the curvilinear recording may be accurate, rapid visual inspection or critical analysis is difficult, at best.

Figure 3-4A shows sine waves reproduced by a BLH Pen Motor and Figure 3-4B shows how sine waves are treated by the curvilinear pen motor. Compare the traces. Note that, once again, the rectilinear trace appears natural while the curvilinear trace looks distorted.



Finally, Figure 3-5A, shows an irregular wave-form reproduced by the BLH Pen Motor; the same waveform is shown recorded on the curvilinear device. Since this is the waveform which probably typifies most of the oscillograms which will be taken in practice, the hidden distortions of the curvilinear device may not be as apparent. However, by remembering the demonstrations in Figures 3-3 and 3-4, it is very apparent that the rectilinear written oscillogram is much to be preferred.

3.3 Electrical Theory.

3.3.1 Electromagnetic Action.

The Pen Motor based on the "moving iron" principle, incorporates a shaft and

soft iron rotor assembly surrounded by two sets of pole pieces, stator windings and biasing magnets. Current passing through the stator windings develops another flux field which interacts with the permanent magnet biasing field and produces a torque on the soft iron rotor.

Precision bearings are mounted at opposite ends of the shaft and a torsion spring is used to return the motor to its zero position when current is removed.

The motor drives a crank assembly to step up the full-scale motor angle to the level angle required for full deflection of the pen. The rear pivot of the pen assembly is allowed to float in the direction parallel to the direction of chart travel.



Figure 3-3A Square Waves Reproduced on BLH Rectilinear Recorder

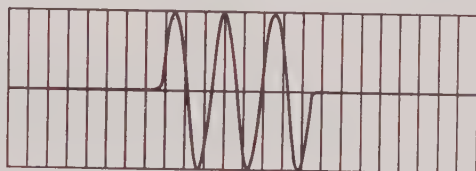


Figure 3-4A Sine Waves Reproduced on BLH Rectilinear Recorder

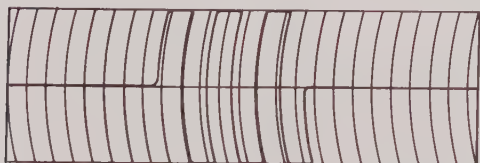


Figure 3-3B Square Waves Reproduced on Curvilinear Recorder

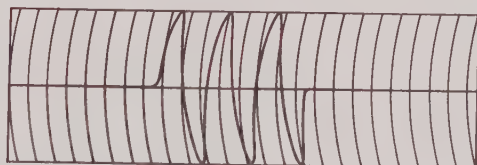


Figure 3-4B Sine Waves Reproduced on Curvilinear Recorder

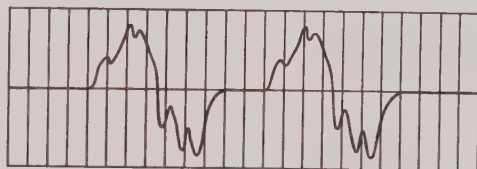


Figure 3-5A Irregular Waves Reproduced on BLH Rectilinear Recorder

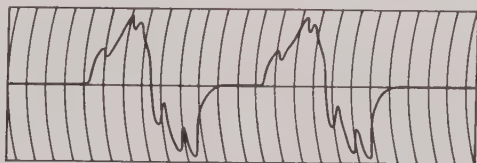


Figure 3-5B Irregular Waves Reproduced on Curvilinear Recorder

This factor, along with providing proper dimensions for the pen and crank assemblies, results in true rectilinear motion of the pen tip.

3.4 Manually Adjustable Electrical Damping.

In BLH equipment there is a potentiometer in series with the coil to provide a manual adjustment of the damping factor over a range of 30% to 110% of critical. The adjustment of this potentiometer is described in paragraph 4.3.1 of Section 4. All Pen Motors installed in BLH Recorders are adjusted at 70% of critical before leaving the factory. All frequency response characteristics are related to 70% of critical. See Figure 4-1 (Section 4) for typical pen motor responses for different values of damping factor.

3.5 The Writing Styli.

BLH Pen Motors may use either electric, ink, or thermotip writing pens or styli. The writing mode may be changed by merely removing one type of pen and installing another. The chart paper must conform to the type of pen used. In multi-channel systems all pens must write with the same mode.

CAUTION: Since the proper operation of the styli depends on correct geometrical relationships of its various elements, the pen should never be bent or otherwise "formed" in an attempt to correct for any misalignment of the pen motor. See Section 2, "Pen Motor Alignment Adjustments".

3.5.1 Ink Pens.

The ink is stored in an air-tight cartridge mounted in clips on the center of the pen motor. The ink is transported to the pen by capillary action through a thin flexible transparent plastic tube.

A mechanical filter assures splash-proof writing at high frequencies. As the pen tip describes a straight line, the pen moves alternately back and forth along its axis during its angular excursion. This pen motion induces pulsations in the ink flow which are rendered ineffective by a built in mechanical filter. This filter, formed by the combination of the air chamber and orifice, neutralizes the pulsations of the ink in the feeder line of the pen assembly to maintain uniform flow at all frequencies.

3.5.2 Thermotip Styli.

The thermotip styli is similar to the ink styli except that the writing tip is formed by two dissimilar metals welded at the junction. This junction is heated through the resistive dissipation caused by the I^2R effect of the heating current and by the application of the Peltier or thermoelectric effect. The concentration of heat is directly at the point of contact between the stylus and the chart paper. The heated stylus contacts a wax-like coating on the chart paper, heats and removes the wax and thus exposes a black background.

Section 4

MAINTENANCE

4.1 General.

This maintenance section is divided into three portions: (1) Preventive maintenance, (2) Corrective maintenance and (3) Parts Lists.

Because the pen motor is an integral instrument, no attempt at maintenance or adjustment other than that given in the following paragraphs should be attempted.

4.2 Preventive Maintenance.

The only daily maintenance required on the recording system is normal cleanliness of stylus and pen motors. Daily remove any ink or residue on pen motors and styli. Water or a mild detergent solution in water are excellent to remove ink stains on the metal.

Keep ink and residue from:

the shaft bearing at the top front of the pen motor.

the linkage housing.

all bearings and surfaces of the styli support arms.

the two parallel pins at the top rear of the linkage housing.

4.2.1 The Ink Feed.

The ink feed in the recording system is of the capillary action type. Quality of the trace is mainly a function of a sealed, unobstructed supply line. If there is an air leak in the ink supply tube, writing will be intermittent. Therefore, it is worth some care to ascertain that all joints in the ink supply are tight and solid.

If good capillary action is established, the ink writing system will work excellently, since the ink supply is virtually sealed, and the ink's viscosity carefully controlled.

4.3 Corrective Maintenance.

BLH pen motor parts are precision machined and thoroughly cleaned prior to assembly in a humidity controlled dust free atmosphere. All sub-assemblies and assemblies are submitted to rigid quality control inspection. These precautions insure long, trouble-free operation.

No field maintenance other than changing the stylus and aligning the pen position should be performed. Any other adjustments should be performed only by BLH personnel since special tools and equipment are required.

4.3.1 Setting the Driver Amplifier Damping Control for 70% of Critical Damping.

The damping control for the Pen Motor is located on the driver amplifier section of the recording system.

The damping procedure consists of balancing and/or calibrating the associated preamplifier. Then, using the preamplifier calibration voltage control, step-voltages are applied and the damping control adjusted until the proper response is obtained. The steps, below, simplify this procedure.

1. Balance and/or calibrate the associated preamplifier.

2. Set the preamplifier Range Switch to a position which will permit the pen to sweep 1 centimeter (10 millimeters) when the preamplifier calibration voltage con-

trol is operated.

3. Center the 1-centimeter sweep using the preamplifier ZERO control. This will cause the pen to sweep 5 millimeters each side of center when the preamplifier calibration voltage control is operated.

4. While alternately operating and releasing the preamplifier calibration voltage control, adjust the pen motor damping potentiometer until the overshoot (spike) is

at the top of the step-function rise is exactly 0.5 millimeters above the horizontal maximum. Figure 4-1B shows this peak.

NOTE: Figures 4-1A and 4-1C show the overshoot characteristics for the extremes of the damping control, that is at approximately 30% (CCW) and 110% (CW) of critical damping.

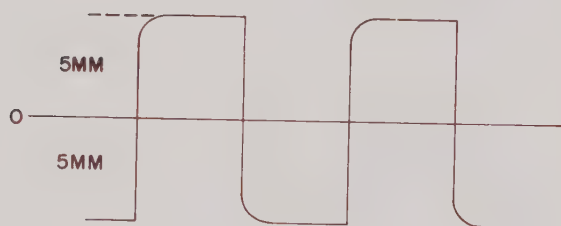


Figure 4-1A Pen Response, Damping Set at 110% of Critical

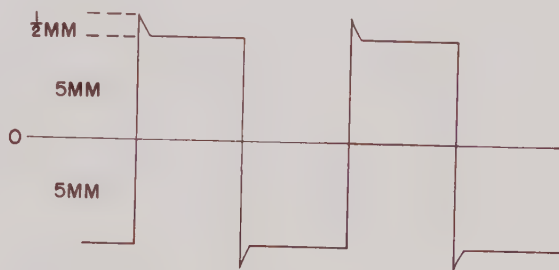


Figure 4-1B Pen Response, Damping Set at 70% of Critical

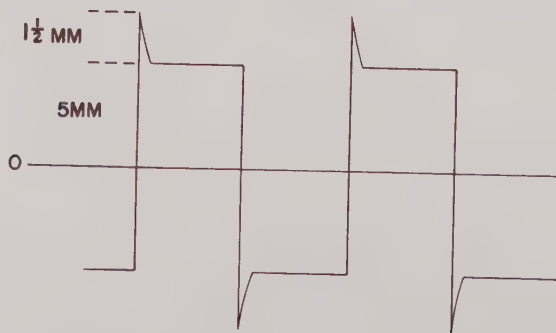


Figure 4-1C Pen Response, Damping Set at 30% of Critical

4.3.2 Removing Obstructions in Ink Pens.

If the styli are used daily there is no need to remove them for cleaning under normal conditions. If, after an extended period of non-use, ink fails to appear on the chart paper, it is obvious that there is an obstruction in the feed line or at the styli tip. An attempt to clear the blockage may be made by priming the system with either a rubber bulb or a Feola pump.

If the pen motor is part of a BLH recording system, depressing the preamplifier 60 cps SIG button (primarily an ink pen primer), applies a 60 cps signal to the pen motor which aids in clearing the feed line. Should the above procedure fail to provide positive results, carefully remove the pen (see paragraph 2.4, Section 2) and insert a wire pen tip cleaner (furnished with each package of pens) into the styli tip. Remove the wire pen tip cleaner and reverse flush the pen, i.e., force distilled water backwards from the pen tip to feed tube. A rubber bulb with a small outlet that will fit over the tip of the pen is convenient for this purpose. The styli should be flushed until all ink has been removed. Replace the pen and once again prime the system with both the pump and the 60 cps (if available).

NOTE: Always leave the pen tip on the paper when the recorder is not in use. This helps to prevent drying at the tip and the recorder will usually be ready for instant writing.

If the pens are to be unused for several days, it is recommended that they be removed and flushed to clean them of ink. This is done by filling an empty ink cartridge with distilled water and using normal priming procedures to flush the

pen.

Reverse flushing, described above, is also effective to clean pens. The pens, once cleaned, should be blown dry with air and left disconnected from the ink supply until the recorder is to be used again.

4.3.3 Setting Pen Pressure.

Pen pressure may be measured by placing the arm of a pressure gage or scale at right angles to the pen and lifting the pen slightly. The pressure should be 1-1/2 grams.

A Hexagon Key (allen wrench) pressure adjustment is provided on Main Recording Styli to make any necessary connection. Insert allen wrench (.028 inches across the flats) into adjusting screw and rotate. Check with pressure gage readjust if required. See Figure 4-2.

Ascertain that the pen in question is not bent by comparing with a new pen. If the pen in question is bent it must be replaced.

On BLH Recording Systems, the Allen wrench and pressure gage are supplied with each Recorder and are located on the side of the chart drive assembly.

4.4 Returning the Pen Motor to BLH for Repair.

Should further repair be deemed necessary, the faulty pen motor should be packed as specified in Section 2, and returned to the factory for expert service.

4.5 Shipping the Ink Writing Recorders.

If it becomes necessary to ship the ink writing recorder at any time, remove all filled or partially filled ink cartridges, wipe the ink feed needle and secure it with an elastic band to the pen motor frame. The ink units should be stoppered and packed in separate sealed containers.

WARNING: BLH will not be responsible for damage done to recorders due to ink spillage during shipment. Failure to remove the ink cartridges will result in a void of the warranty.

4.6 Parts Lists.

Table 4-1, the List of Replaceable Parts furnishes a complete list of pen motors, pens, ink and accessories. All parts should be ordered by the specified BLH part number.

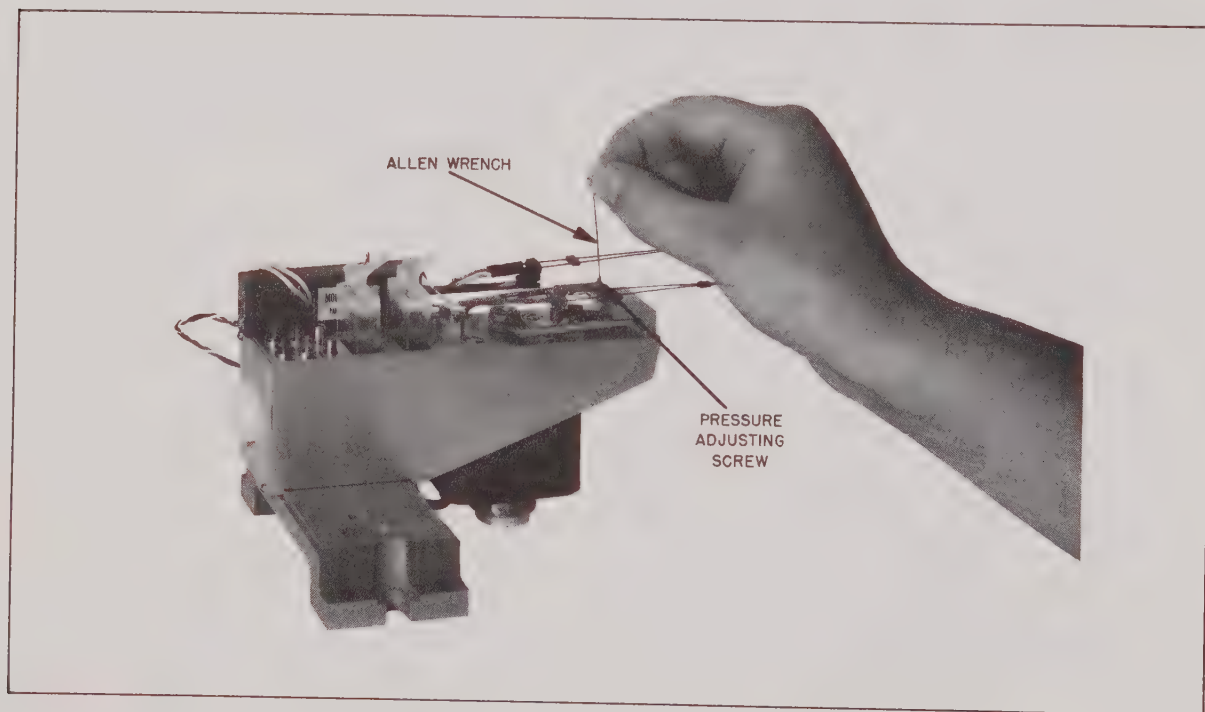


Fig. 4-2 Adjusting Pen Pressure

TABLE 4-1
LIST OF REPLACEABLE PARTS

DESCRIPTION

BLH
PART NO.

TABLE 4-1A PEN MOTORS

PEN MOTOR, Model OS-700 (less pen)	281733-4
------------------------------------	----------

TABLE 4-1B PENS, ANALOG WRITING

PEN ASSEMBLY, INK	281677-3
PEN ASSEMBLY, THERMOTIP	25.00 42 ⁰⁰ <u>281490-3</u>

TABLE 4-1C PENS, EVENT MARKING

PEN ASSEMBLY, INK	281914-2
PEN ASSEMBLY, THERMOTIP	15.20 36 ⁰⁰ 281789-2

TABLE 4-1D EVENT MARKING ASSEMBLY

EVENT MARKER, OS-700 MOTOR (less pen)	281759-2
---------------------------------------	----------

TABLE 4-1E INK CARTRIDGES

RED	281296-1
GREEN	281297-1
BLUE	281295-1
BROWN	281299-1
RED, fast drying	281300-1
RED, low temp.	281301-1
BLACK	281302-1
PURPLE	281303-1

TABLE 4-1F INK CARTRIDGE ACCESSORIES

CAP, RUBBER	A-13172-1
INK CARTRIDGE, RECTANGULAR	A-14041-501
INK FEED NEEDLE, for ink cartridge	A-14037-1
INK FEED TUBING, for main stylus	A-14047-1
INK FEED TUBING, for event marker stylus	A-14047-2
PRIMER, hand air pump (Feola)	141817-8

TABLE 4-1 (Cont.)

DESCRIPTION

BLH
PART NO.

TABLE 4-1G CHART PAPER, 40 MILLIMETER, INK WRITING

2 CHANNEL, grey grid lines, 150 ft. lg.	BSA-250	241K
2 CHANNEL, red grid lines, 150 ft. lg.	BSA-250	242K
4 CHANNEL, grey grid lines, 400 ft. lg.	BSA-450	441K
4 CHANNEL, red grid lines, 400 ft. lg.	BSA-450	442K
6 CHANNEL, grey grid lines, 400 ft. lg.	BSA-650	641K
6 CHANNEL, red grid lines, 400 ft. lg.	BSA-650	642K
8 CHANNEL, grey grid lines, 400 ft. lg.	BSA-850	841K
8 CHANNEL, red grid lines, 400 ft. lg.	BSA-850	842K

TABLE 4-1H CHART PAPER, 40 MILLIMETER, HEAT WRITING

2 CHANNEL, red grid lines, 110 ft. lg.	BSA-270B	242H
4 CHANNEL, red grid lines, 375 ft. lg.	BSA-470B	442H
6 CHANNEL, red grid lines, 375 ft. lg.	BSA-670B	642H
8 CHANNEL, red grid lines, 375 ft. lg.	BSA-870B	842H

APPENDIX A

MODEL PS-201B

HEAT WRITING POWER SUPPLY

AND

MODEL FAC-201B

AUTOMATIC HEAT CONTROL

BLH MANUAL CHANGES
METERITE
Models BSA-250B /270B

TM No. 251-265

Changes in Instructions:

Place the following list of addenda and errata in the front of the Manual following the title page, after making the changes noted.

Errata:

Delete the Following:

Figure 4-22 - Photo Heat Writing Power Supply and Panel, Model PS-200B.

Figure 4-9B, PS-200B Heating Writing P.S. Schematic Diagram.

Table 4-5, List of Replaceable Parts for 200B.

Paragraph 4.7 - Installing the Heat Writing Power Supply (on Model 250B only).

Figure 4-19 - Meterite Schematic Diagram.

Addenda:

Instruction Manual for Model PS-201B Heat Writing Power Supply and Model FAC-201B Automatic Heat Control.

Replace Figure 4-19 with Drawing #282539 Meterite Schematic Diagram.

Correction:

On Figure 4-18 Driver Amplifier Model DA-101B, Schematic Diagram, connect J103C to junction of C104, a 3 ufd capacitor, and R120, a 1.8 ohm resistor.

SECTION 1

INTRODUCTION

1.1 General

This instruction manual provides information regarding the description, theory and maintenance for the Manual Heat Writing Power Supply, Model PS-201B and the Automatic Heat Frequency Amplitude Control Amplifier, Model FAC-201B.

1.2 The Model BSA-270B Meterite

The Meterite Model 270B contains the Model PS-201B Power Supply with Thermotip Writing Stylus. The Meterite Model 270BA contains in addition to the PS-201B Power Supply, an Automatic Heat Frequency, Amplitude Control Amplifier. The Model BSA-270B can be easily and quickly converted to the Model BSA-270BA by the simple insertion of a printed circuit plug-in board containing the frequency amplitude control circuitry. The procedure is fully described in Section 4, paragraph 4.3.

1.3 Model PS-201B Power Supply

The variable DC current power supply is a fully transistorized power unit with manual control for setting the intensity of the recorded Thermotip pen line.

1.4 Automatic Heat Writing

The Automatic Heat Frequency Amplitude Control Amplifier, Model FAC-201B is a fully transistorized unit that varies the current in the Model PS-201B power supply automatically for changes in frequency or amplitude of the incoming signal.

SECTION 2

OPERATION

2.1 General

This section provides information on the method of operation to obtain optimum results in the use of Thermotip Writing, both in manual heat writing and automatic heat writing. The controls mentioned will only concern this function.

2.2 Controls

The controls for manual or automatic heat writing are located on the rear of the top deck of the Model 270B or BA Meterite as illustrated in Figure 1-3B (see page 1-3 of the Meterite Instruction Manual).

2.3 Thermotip Writing Control Settings

Control	Initial Setting	Operating Setting
Heat Writing Power Switch	Off (left)	On (right)
Range Switch Lo/Off/Hi	Off	Lo or Hi as required
Pen Line Intensity Controls	Fully Counter-clockwise	Adjust clockwise to obtain well defined pen line. (See note)

Note: The Manual Heat Writing Power Supply requires the setting of the pen line INTENSITY controls for each signal variation of amplitude or frequency and chart speed to obtain the best pen line intensity. The Automatic Heat system requires only an initial setting and will automatically compensate for variations of signal amplitude or frequency and chart speed.

SECTION 3

THEORY OF OPERATION

3.1 Manual Heat Power Supply

Figure 3-1 shows the schematic diagram of the PS-201B Power Supply.

(Refer to Drawing 282506-3)

Figure 3-1 Schematic Diagram

PS-201B Power Supply

The PS-201B Power Supply is a Class (B) Power Amplifier. The voltage across the resistor network R16, R1006, R1011 and R1008 is regulated by a 6.2 volt Zener diode Z1001. R1011, Channel #1, Pen Line Intensity Control, is varied, setting the base voltage of Q1005. The output of Q1005 sets up the bases of Q1003 and Q1004 to pass the amount of current required on the positive half cycle of the AC applied to their respective collector. R1004 is selected for a minimum current with R1011 set at minimum.

Since the event marker heat stylus requires a minimum of current at all times, Diode D1004 is placed across the event marker stylus to limit the current.

On the highest two chart speeds, a microswitch is closed by the chart speed selector mechanism shunting R1008 by R1009. This will automatically increase the current through the stylus.

3.2 Automatic Heat Amplifier

Refer to Figure 3-2, a schematic diagram of the Automatic Heat Frequency Amplitude Control Amplifier.

(Refer to Drawing 400575-3)

Figure 3-2 Automatic Heat Frequency
Amplitude Control Amplifier

The output of the Driver Amplifier is fed to the primary of T11. The secondary voltage of T11 feeds the incoming signal to the respective base of Q11 or Q12. A DC bias is supplied the bases by the setting of the pen intensity control. The signal is amplified (gain of 1), rectified, and integrated by C14, and again amplified by Q13 (gain of 1). The output is then fed to the base of Q1005 in the PS-201B power supply.

SECTION 4

MAINTENANCE

4.1 Routine Maintenance:

There is little required in the way of routine maintenance. Where the recorder is to be used in dusty environments, it is a good practice to occasionally clean away any accumulation of dust with a brush and low pressure air, especially in the area below the transformer.

4.2 Trouble Shooting Procedure for the Manual and Automatic Heat System:

Where faulty operation is apparent, a thorough check of the following is necessary before attempting repair:

- (a) Correct stylus pressure against chart paper.
- (b) Check that the stylus tip is not broken or destroyed in any way.
- (c) Leads to stylus are not open.
- (d) Plugs attached to rear of pen motor housing are firmly seated.

If the above are found to be normal, proceed with voltage checks of the power supply.

4.2.1 Test Equipment Required:

An accurate high impedance input voltmeter. (vacuum tube)

A D-C clip-on milliammeter, Hewlett-Packard Model 428B or equivalent, must have a range of 0-10 amps.

4.2.2 Removal of Power Supply:

To gain access to the Manual or Automatic Heat Power Supply, perform the following steps:

- (a) Remove the back panel of the meterite, but do not disconnect any leads.
- (b) Pull out the recorder section drawer to its stop.
- (c) The Heat Power Supply is the unit mounted between and at the rear of the guide rails of the recorder section.
- (d) If the power supply location is such that it is difficult for you to gain access to the various test points, perform Steps "e" through "g". If the power supply is to be left in place, skip to Step "h".
- (e) Turn the meterite on its side and remove the four (4) screws that hold the power supply to the main deck.
- (f) Turn the meterite back on its base and disconnect the leads of the power supply cable harness that are attached to Terminal Board 201. Record color code of wire and terminal number it was removed from in order that no mistake is made in reassembly.

- (g) Slide power supply out of meterite case. Reconnect wires removed in Step "f".
- (h) Turn recorder power ON.
- (i) Turn heat writing power ON.
- (j) Place clip-on ammeter over stylus lead wire in the proper direction to indicate up-scale on the meter.
- (k) Turn Chart Range Switch to LO (use lowest chart speed).

4.2.3 Voltage Check:

Refer to Figure 3-1, a schematic diagram of the power supply, and Figure 4-1, a wiring diagram of the manual and Automatic Heat Power Supply to locate test points as indicated in Table 4-1.



REFERENCE :-

1. E142 = SOLDERLESS TERMINAL - SOLDER RING 3/16 SIZE REFERENCE 1.
2. E3 THRU E6 = DTC 12319-2-JOB CONNECTOR
3. ALL LEADS FROM MAIN CABLE TO THIS ASSY (C) E1 THRU E6 ARE TO BE IDENTIFIED WITH SPECIFIC E NUMBER & CONTAIN SOLDERLESS TERMINALS AS SPECIFIED IN NOTE 142.
4. Q1001, THRU Q1004, LEADS TO TH01 TO BE 16 GA # HAVE SUFFICIENT SERVICE LOOP THRU GND INTO TS0101.
5. ON MAIN & AUTO HEAT, LEAD "E2" IS TIED BACK & THROD, NOT USED.

[illegible]

Drawing (282504-3)

Figure 4-2 Schematic Diagram Automatic Heat Control

4.3 Converting Manual Heat Writing Power Supply to Automatic Heat Writing

The manual Heat Writing Power Supply can be easily converted to a Automatic Heat Writing System as follows:

- a. Remove the Printed circuit board assembly number 282540-1 from P1001
- b. Insert printed circuit board assembly number 400560-3 into P1001. The unit should now Automatically Compensate the heat for frequency and amplitude variations.

Table 4.1
Voltage Table PS201B and FAC-201B

Test Points			
(+) From	(-) To	AC Rms	DC.
TB1001-1	TB1001-2	115	
PC1001-1	PC1001-6	18.6	
PC1001-5	PC1001-4 or 11		12.0
Across Z1001			6.2v $\pm$ 10%
R1011 Slider	PC1001-4	Manual P.S. Only	with R1011 at minimum + .5 with R1011 at maximum + .75
		Automatic Heat	with R1011 at minimum +2.1 with R1011 at maximum +2.3
J1001-15	PC1001-4	Automatic Heat Only	with R1011 at minimum + .5 with R1011 at maximum + .75
PC1001-14	PC1001-4		minimum +2.5 intensity maximum +2.0 intensity
T1001-5	T1001-4	3V	
T1001-4	T1001-3	3V	
T1001-5	TB201-10		minimum + .7 intensity
T1001-3	TB201-10		maximum +2.5 intensity
Auto Heat Only FAC-201-B			
P1001-9 (+) Base Q13	P1001-12 (-) P1001-12		6.0 1.1 Volt to 1.4V Full amplitude

Table 4-2

Current Through Stylus for Normal Operation

Condition	Current Through Stylus	
	Manual	Automatic
1. Intensity-minimum	1.4 Amps	1.4 Amps
2. Intensity-maximum (No signal in)	6.0 Amps	4.0 Amps
3. Intensity set to obtain good trace (No signal in)	2.5 Amps	2.5 Amps
4. Full amplitude A-C signal (4 cm chart width)		6.0 Amps
5. Chart speed changed to 50 or 200 mm/sec with condition #4		6.5 Amps
6. Effect of Frequency with signal of 2 cm amplitude		
1 Hz	3.0	3.0
2 Hz	4.0	4.0
3 Hz	5.2	5.2
4 Hz	5.0	5.0
Flat To		
90-100		5.5
110-120		6.0

TABLE 4-3

List of Replaceable Parts for PS-201 B

Circuit Symbol	Description	Mfr. Code	BLH Part No.
C 1001	Capacitor 500 uf @ 25VDC	CD	131206-8
D 1001	Diode, #ED-3001	ER	140342-8
D 1002	Same as D 1001		
D 1003	Diode, #368-A	WES	142012-8
D 1004	Same as D 1003		
J 1001	Connector, 143-015-01	AMH	
Q 1001	Transistor, 2N457A	TEX	140038-8
Q 1002	Same as Q 1001		
Q 1003	Same as Q 1001		
Q 1004	Same as Q 1001		
Q 1005	Transistor, 2N3054	RCA	
Q 1006	Same as Q 1005		
R 6	Resistor, Comp. 68 ohms, $\frac{1}{2}$ watt, 10%	AB	127204-8
R 16	Same as R6		
R 1001	Resistor, Comp. 4.7K, $\frac{1}{2}$ watt, 10%	AB	127220-8
R 1002	Resistor, Carbon film 680 ohms, $\frac{1}{4}$ watt, 1%	PEN	140841-8
R 1003	Resistor, Comp. 330 ohms, 2 watt, 10%	AB	132369-8
R 1004	Same as R 1003		

TABLE 4-3

List of Replaceable Parts for PS-201 B (Cont.)

Circuit Symbol	Description	Mfr. Code	BLH Part No.
R 1005	Resistor, Comp. 820 ohms, $\frac{1}{2}$ watt, 10%	AB	129851-8
R 1006	Same as R 1005		
R 1007	Resistor, Comp. 100 ohms, $\frac{1}{2}$ watt, 10%	AB	127206-8
R 1008	Same as R 1002		
R 1009	Same as R 1001		
R 1010	Resistor, Potentiometer 100 ohms,	CLA	133714-8
R 1011	Same as R 1010		
R 1012	Resistor, Comp. 10K, $\frac{1}{2}$ watt, 10%	AB	127230-8
R 1013	Same as R 1012		
S-1001	Switch	AHH	141417-8
T 1001	Transformer	AT	282430-1
TB 1001	Terminal Board		124868-8
Z 1001	Diode, Zener LMZ - 6.2V	Semcor	135654-8

TABLE 4-4

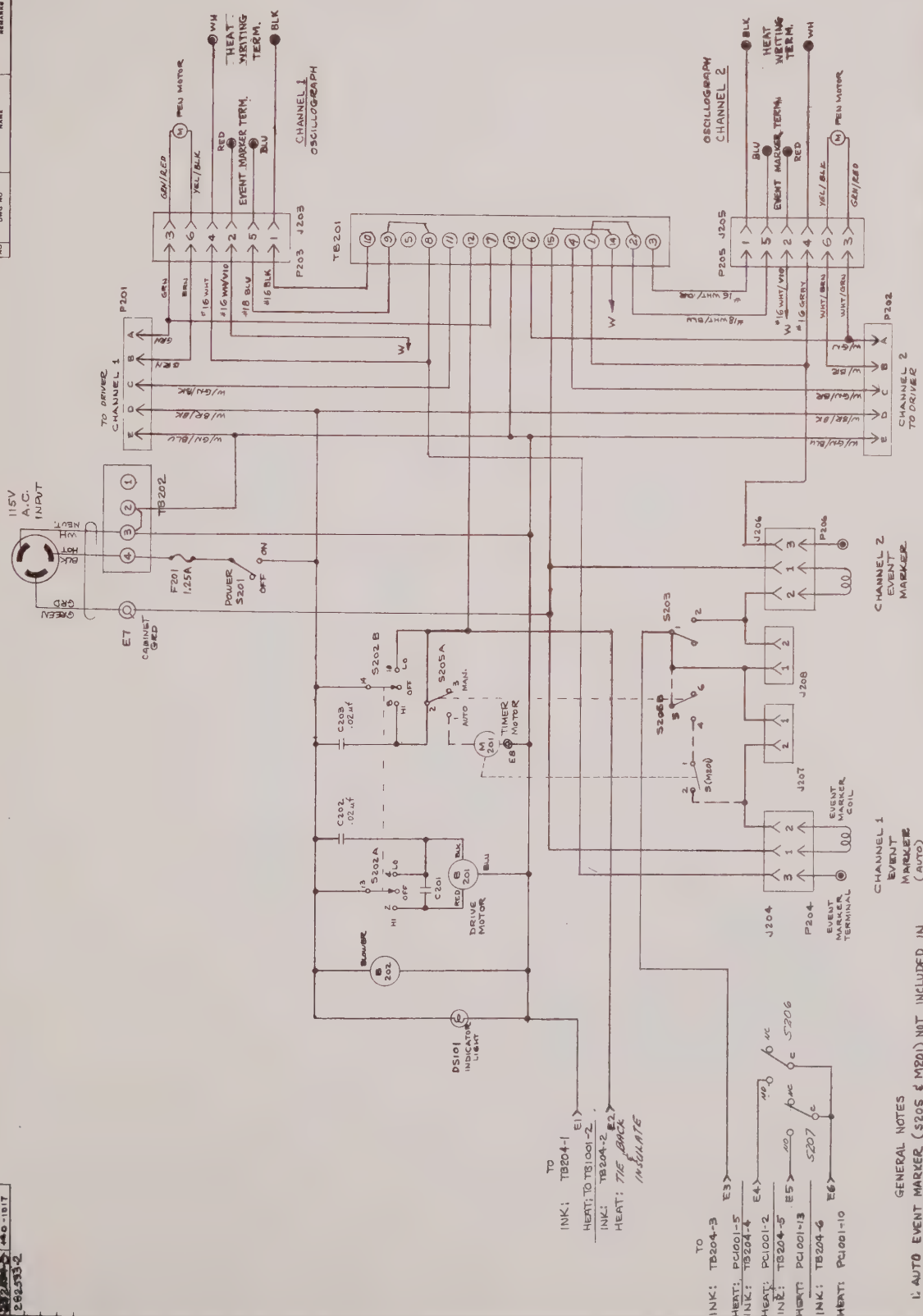
List of Replaceable Parts for FAC-201B

Circuit Symbol	Description	Mfr. Code	BLH Part No.
C1	Capacitor 10 uf @ 25VDC	SPR	140145-8
C2	Same as C1		
C3	Capacitor .22 uf @ 100VDC	MAL	142147-8
C4	Same as C1		
C11	Same as C1		
C12	Same as C1		
C13	Same as C3		
C14	Same as C1		
D1	Diode ED3001	ER	140342-8
D2	Same as D1		
D11	Same as D1		
D12	Same as D1		
Q1	Transistor		278512-1
Q2	Same as Q1		
Q3	Same as Q1		
Q11	Same as Q1		
Q12	Same as Q1		
Q13	Same as Q1		
R1	Resistor, Comp. 2.2K, $\frac{1}{2}$ Watt, 10%	AB	127222-8
R2	Same as R1		

TABLE 4-4

List of Replaceable Parts for FAC-201B (Cont.)

Circuit Symbol	Description	Mfr. Code	BLH Part No.
R3	Resistor, Comp. 10K, $\frac{1}{2}$ Watt, 10%	AB	127230-8
R4	Same as R3		
R5	Resistor, Comp. 1K, $\frac{1}{2}$ Watt, 10%	AB	127218-8
R6	Resistor, Comp. 750 ohms, $\frac{1}{2}$ Watt, 5%	AB	129850-8
R11	Same as R1		
R12	Same as R1		
R13	Same as R3		
R14	Same as R3		
R15	Same as R5		
R16	Same as R6		
T1	Transformer	TENCO	401523-1
T11	Same as T1		

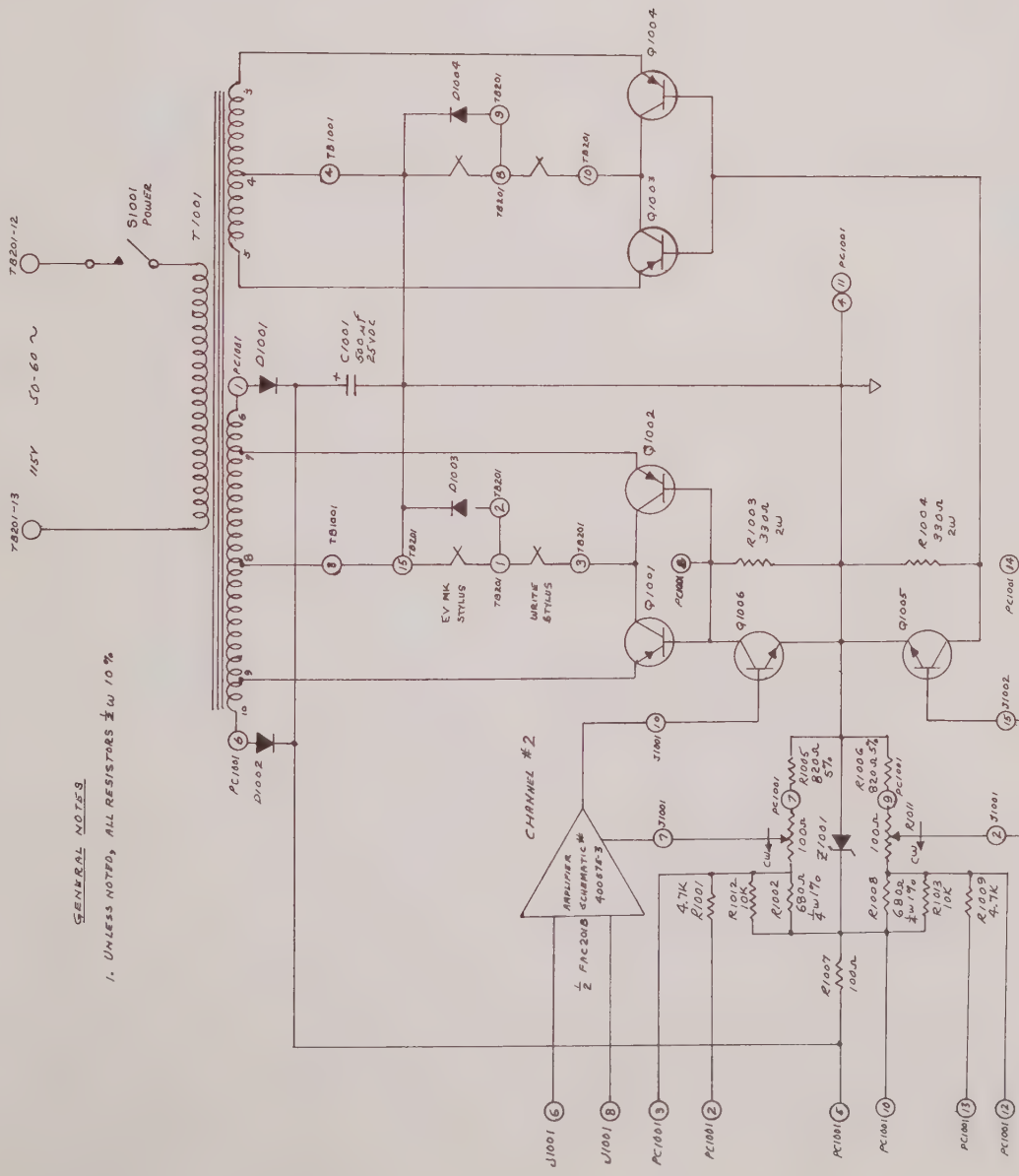


GENERAL NOTES

1. AUTO EVENT MARKER (SDOS & M201) NOT INCLUDED IN STD. METERITE, MAY BE ADDED AS SHOWN IF REQUESTED BY CUSTOMER ON ORDERING SPEC. STD CABLE TO INCLUDE WIRING FOR AUTO EVENT MARKER.

[illegible]

...to two

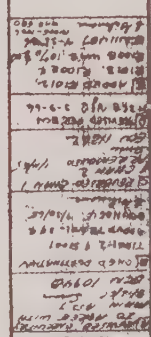


GENERAL NOTES

1. UNLESS NOTED, ALL RESISTORS $\frac{1}{2}$ W 10%

UNLESS OTHERWISE NOTED FACT YOL. 2-1-68 DESIGNATION FOR 3-1/2" x 100, MACHINE FINISH 30 PROTECTIVE FINISH	DRAWN _____ CHECKED _____ APPROVED _____ RELEASED _____ E R N _____ SCALE _____	BLH ELECTRONICS A DIVISION OF ION CORP. BALDWIN ST. WALTHAM 24, MASSACHUSETTS SCHEMATIC AUTOMATIC FAC-261B	REV. _____
REVISIONS		2825-04-	3

70201-13



1. ARE NO'S APPEARING IN CIRCLES ARE TERMINAL
POINTS LOCATED ON PC-1001 (900559-2) UNLESS NOTED.

2. UNLESS NOTED, ALL RESISTOR $\frac{1}{2}$ W 10%

Abstract

6-105888
6-108357

SALES AND SERVICE OFFICES

UNITED STATES and CANADA

086 Seatronics
5931 Fourth Ave.
Seattle, Washington 98108
(206) 767-4330
TWX: 910-444-2073

110 Barnhill Associates
4900 E. Indian School Rd.
Phoenix, Arizona 85018
(602) 959-2115
TWX: 910-950-1283

Barnhill Associates
1170 S. Sheridan Blvd.
Denver, Colorado 80226
(303) 934-5505
TWX: 910-867-7411

Barnhill Associates
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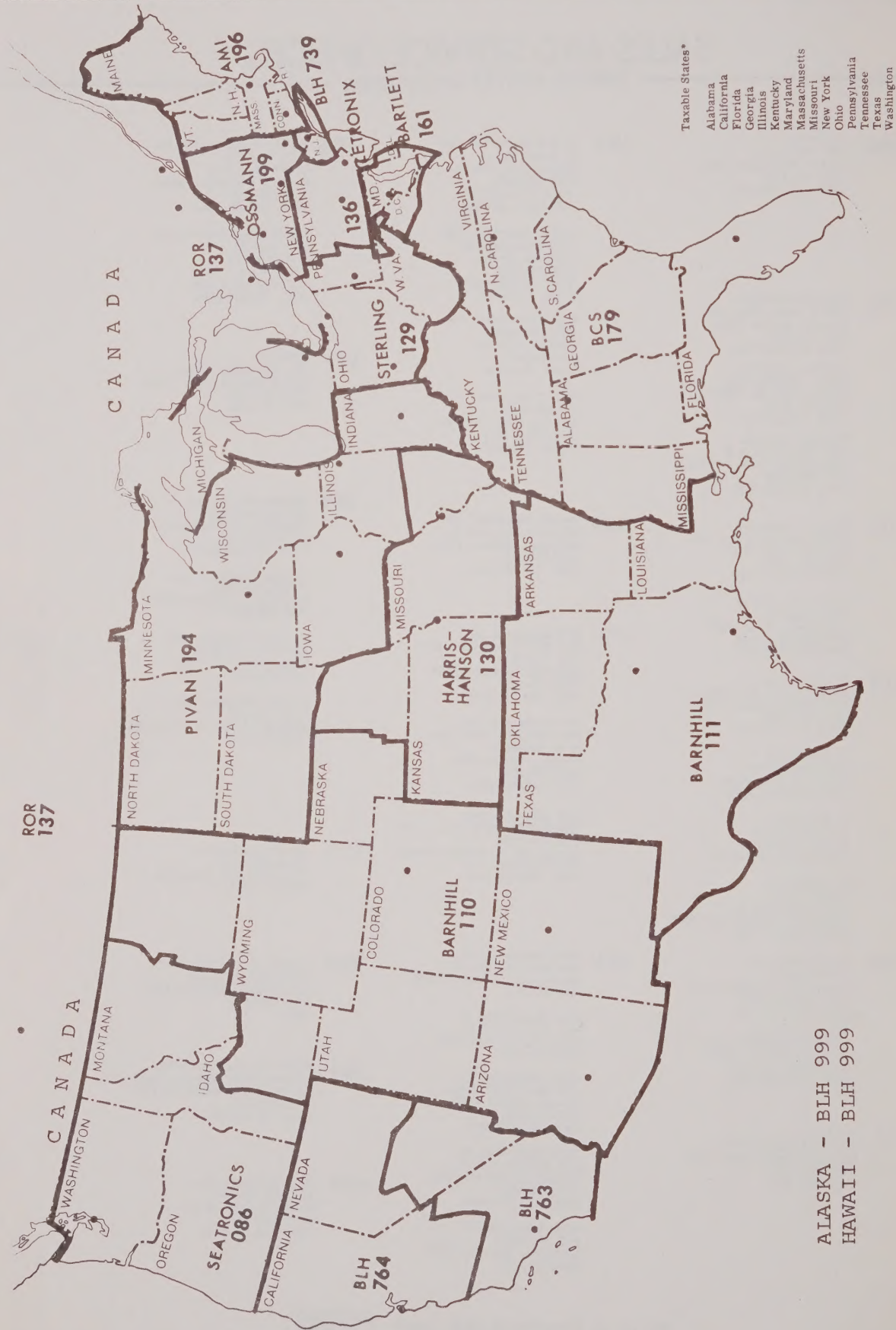
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